THE

ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1900

Edition

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THE BRITISH NAVAL ENGINEER.

WHICH is the more important part of a ship of war, its guns, or its engines and machinery? This seems to be the question at issue between the two branches of the Naval service. Sensible men would say neither can be of much use if the other fails. A paper by Mr. D. B. Morison before the North-East Coast Institution of Engineers and Shipbuilders, on March 30th, was evidently written with a view to pointing out what we all seem to think, that the engineering side is starved by the Admiralty, and that, as a whole, our Navy is far from properly manned. It appears to be the opinion of the fighting men that the engineers are a nuisance, to be snubbed on all occasions, and the Admiralty, whatever that body may be, concede so much to the prejudice of a class or division, that the British Empire is in positive danger, or would be if we went to war; for no matter how the patriotism of the engineers of the mercantile marine might lead them to fill the breach, they could not possibly acquire the necessary knowledge to properly work the machinery in the short time available for so doing. We have reason to believe that, assuming the existence of the necessary patriotism, the difficulties foreseen by Mr. Morison would not be so severe as he anticipates. In the event of war, and an accession of outside men, the special machinery would be looked after by the existing staff of engineers, while the propelling machinery would come under the care of the freshly imported mercantile engineers, who would soon master this portion of the duty. We believe, if the Admiralty have any ideas or knowledge of the question at all, that this is the view taken by them, but far be it from us to say that such a course of conduct is wise. It is indefensible; in fact, it is positively wicked. Here we are with our country denuded of regular troops, and what excuse can be made for our Government which suffers such things to be? Let us take a few facts from Mr. Morison's paper. In 1878 the so-called executive *personnel* of the Navy was 27,911 in number, as against the engineering *personnel* of 5,627, whereas in 1898 the relative numbers were 44,336 and 22,289, an enormous addition to the engineering side, clearly showing its growing importance. Yet the engineering side, it is said, is not even represented on the Admiralty Board.

It appears that even with the short-handedness allowed there are not candidates for the engineering department of the Navy, and so-called temporary service engineers and direct entry engineers are admitted on qualifications very much below that necessary to be possessed by Keyham students.

Much of the trouble, we are convinced arises from the expense of putting a boy through Keyham. This amounts to £576—a sum quite beyond the pockets of many gentlemen. If our naval engineers are to have the manners of gentlemen, they must come from suitable homes, and entry to the Navy ought to be merely a matter of fitness, after

which the necessary training should be reasonable in cost, and the pay should be sufficient afterwards. As the cost of entering the executive side is only £494, and the subsequent pay is better, and the prospect of strutting about in gold lace is understood to be more extended, it is only natural that the engineering branch should suffer.

But the great trouble, and apparently the fatal one, is that if an engineer is supposed to have done wrong, he is Court-martialled by executive officers who don't know one end of a connecting rod from the other, and if a stoker does wrong, he has to attend with the engineer before an executive officer, and the engineer has no command over his own men. This causes trouble, especially as naval stokers are drawn from outside ranks of labour, and there is no system of training stokers for the Navy.

Another trouble in the Navy is the extreme short-handedness of all the ships. Thus the *Terrible*, with her 25,000-H.P. engines and doubtful Belleville boilers, carries 7 engineers and 1 artificer engineer, as well as 3 chief engine-room artificers and 15 engine-room artificers, who are mechanics without responsibility; also, we assume, firemen.

The *Lucania*, of the Cunard Line, with 28,000 H.P. and practical boilers, carries 22 engineers, 2 electricians, 1 boiler maker, 24 greasers, 78 firemen, 60 trimmers, 2 storekeepers and 2 donkeymen.

The *Oceanic*, of 28,210 H.P., carries 23 engineers, of whom 15 hold first-class B.O.T. certificates, and 34 greasers. Mr. Morison gives a long list of such comparisons, showing an alarming inferiority in the manning of the Navy. Worse still, important duties are filled by men of far too short an experience, duties they could not fill in time of war, and it may be truly said that in both men and *morale* a first-class battleship is far worse equipped than any ordinary liner. Yet an empire of 12 million square miles may hang upon the capacity of a single ship at a critical moment.

It is only recently that a large cruiser ran a 60 hours' trial at seven-eighths full speed, and 60 additional men had to be taken on to trim coal. The vessel in question has no fewer than 50 coal bunkers.

In 1892 the Admiralty committed the error of reducing the engine room complements, already admitted to have been inadequate by no less than 12 per cent. As Mr. Morison says, failure is ahead—certain and disastrous failure—and all that is required to develop it is a naval war. This is a very serious state of affairs. It is one that is blinked at by the short-sightedness that rules our Navy, which is endangered by inability to recognise that the engineering side is fully as important as the so-called fighting side. In the navy of the United States we believe great improvement has been made under the able leadership of the Chief Engineer, Rear-Admiral George W. Melville.

It seems incredible that the fleet engineer of the *Powerful* only receives a pay of 9s. per day as charge pay when in charge of a ship, in addition to the ordinary pay, which is only 10s. per day up to 30 years of age, while all the ships of the *Polyphemus* class have had the charge pay cut down to 6s. per day and have only two assistant engineer officers.

Promotion is so slow that a man is 38 or 40 years of age before he becomes chief, and he does not become fleet engineer until he is 46 or 48. Men are retired at 55.

It is also a hardship that the executive officers can call off any men of the engine room staff at will, and that by doing so they often completely disorganise the work in port, whereas the responsibility of the engineer is not diminished by this high-handed proceeding.

The engineer cannot communicate with his own engineer-in-chief. Everything must go through the captain, who has power to comment thereon or to suppress it, and in any case must have it transcribed and forwarded in his own name, whereby the very individuality of the engineer is lost. This is totally wrong. When, in time of war, the whole ship is in a tight place, it will not be the engineer who will be helpless. It will be his place to remain below, and do his duty without any of that stimulus which comes from the privilege of seeing the fight. His ordeal will be that of listening and of watching for the next shell to send his steam pipes adrift to scald him, perhaps to death. We are all proud of our naval men, and it is as much in their interests as in those of the engineers that we would have fair treatment all round. Our Navy never can be efficient while any one limb is withered, and the country should see to it that, before it is too late, the British Navy is put into a fit state of offence and defence. We have had our lesson in the Army, and it should not need to be repeated in the Navy. Do not let us be carried away by the nonsense which confuses wise preparation with panic. The lack of wise preparation would have lost us South Africa if the Government had not been figuratively kicked to their duty. It is extremely difficult to reform the Navy. The Board of Admiralty seems to be a sort of close Corporation, whose feelings are ultra-conservative, and quite out of harmony with all modern ideas and modern methods. The Admiralty appears absolutely apathetic in face of what is universally recognised to be a serious situation. Mr. Morison calls especially on marine men to raise their voices in demand of reform. He suggests the formation of a committee to deal with the matter, an organised body representative of the engineering profession of the country. We endorse this recommendation, and our columns are open to extend its views. We think every true Briton will endorse it. The interests of the country are paramount and should take precedence of red-tape-tied Admiralty officialism. If reform injures such officials, they must be put aside. The Empire demands something different from what now obtains. There must be some good reasons underlying the discontent in the Navy which has been brought to our notice in many ways. It should certainly receive investigation by an unofficial committee, and that at once.

A New Feature.

We publish in our present issue a "Legal Query Column" which we venture to hope may continue to be a feature of the Electrical Review. Owing to the number of questions which have been directed to this office with regard to the law of electric lighting and kindred subjects, it has been thought wise to confer upon inquirers the benefit of such advice as our legal correspondent may be able to give when placed in possession of a short statement of the facts; and further, to give our readers generally the full benefit of such opinions by publishing both questions and answers. In estimating the value of the opinion expressed by our legal correspondent upon the points laid before him, it should be borne in mind that no lawyer can pledge himself to an opinion unless he has had an opportunity of considering all the facts and documents in the case. While, therefore, an opinion obtained through the medium of our query column must not be regarded as a substitute for professional advice, it is hoped that it may be useful when the facts of a case are simple and capable of accurate expression in a few words.

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gentlemen, they must come from suitable homes, and entry to the Navy ought to be merely a matter of fitness, after

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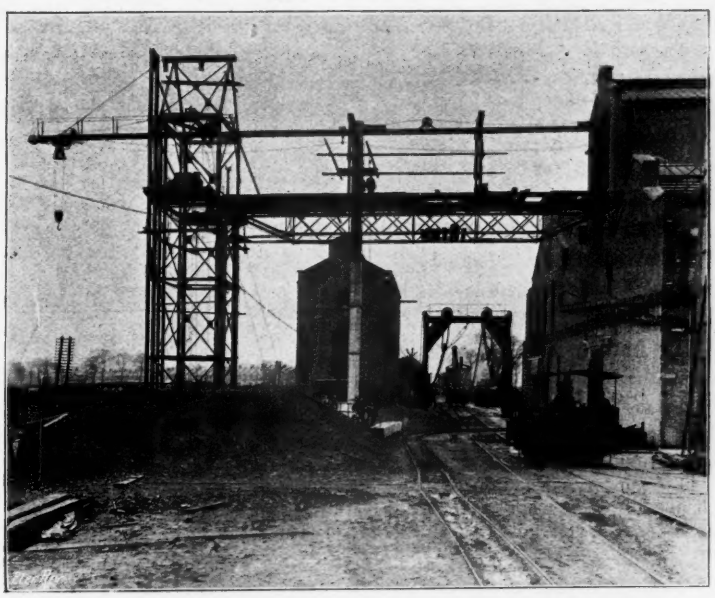
THE WILLESDEN ELECTRICITY WORKS OF THE METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

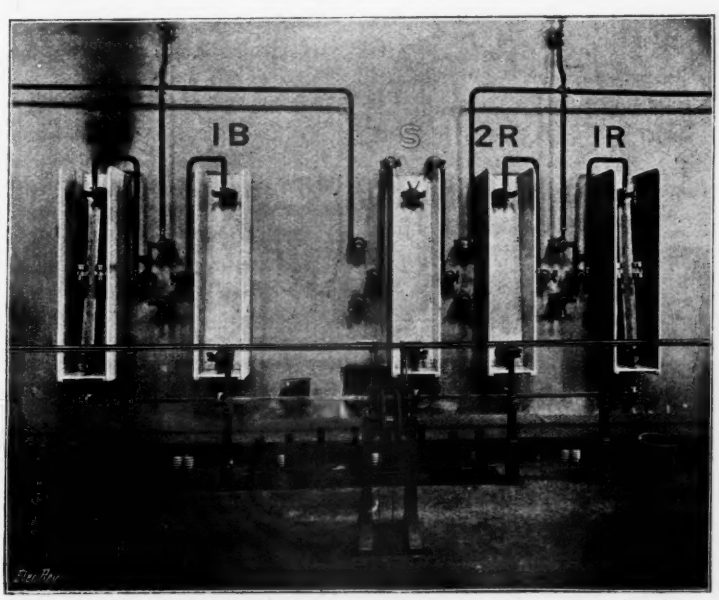
(*Concluded from page* 493.)

Two smaller transformers are provided in connection with the "mains discharger," the handling gear of which is seen in the middle of the transformer room. This is rendered necessary by the capacity inseparable from such long and heavy concentric mains as those from Willesden to London, in which, if suddenly switched on at a pressure of 10,000 volts, violent surgings would take place, causing extreme variations of pressure, and endangering the insulation of the cables. Exactly the same difficulty was experienced at Deptford, and was overcome by Mr. G. W. Partridge, whose "mains discharger" has been adopted at the Willesden station. The device consists simply of a transformer and a variable water resistance; the high tension (primary) coil of this is joined in series between the bus bars and the main to be charged, while the low tension (secondary) is on open circuit, under which conditions the current flowing into the main is small. The water resistance is then joined across the terminals of the secondary coil and gradually diminished, until it is finally short circuited; in this case the impedance of the primary coil is very small, so that it may be short circuited also, leaving the bus bars directly connected with the main cable.



COAL TRANSPORTER AND GOLIATH CRANE.

The main fuseboard, which is placed opposite the bank of transformers, is shown in one of our illustrations, together with the high tension bus bars and the mains discharger gear. The bus bars, of $\frac{7}{8}$-inch diameter copper rod, are carried round the walls on insulators, and are arranged in two rings—one for the "red," and one for the "blue" phase—with disconnecting pieces at intervals. The fuseboard consists of compartments composed of marble slabs partly surrounding the fuses, which are duplex, and are constructed after Mr. Mordey's pattern—fine wires stretched in a glass tube, partly filled with sand; although the sand to a great extent destroys the arc at the moment of fusion, that a considerable flare-up may take place is clearly shown by the dark patch on the wall over No. **2 B** in the figure.



10,000-VOLT FUSEBOARD AND MAINS DISCHARGER GEAR.

The arrangement by means of which the mains and the mains discharger are connected, consists of the terminals seen between the panels; the uppermost of these are connected with the high-pressure bus bar on either the blue or the red phase; the lowest are connected with one pole of the high-tension coil of the corresponding transformer used for charging the mains, the other pole of which is coupled to the bus bar through a switch and fuse; the middle terminals are joined through the fuses to the insulated inner conductors of the main cables respectively. As the outer conductor, and one pole of each main transformer, are always earthed, the inner alone has to be dealt with in connecting up the cables; two of these are for the red, and two for the blue phase, while a fifth cable is spare, and can be used for either phase. In charging a cable, the first proceeding is to couple the inner conductor to the charging transformer by a connecting bar, and to switch the transformer into connection with the bus bar, the secondary coil being on open circuit. A load is then gradually thrown on the secondary by means of the levers seen in the foreground of our view of the fuseboard, with which the water resistance in the room below is slowly cut out; when the resistance in the secondary is reduced to a minimum, the transformer is almost non-inductive in effect, and the bus bar is practically direct-connected with the main. Finally a connecting bar is inserted into the terminals of the bus bar and main, and the transformer connections are broken, leaving the bus bar in direct communication with the main, as in the case of **1 R** and **2 B** in the adjoining figure.

As stated above, there are five main cables, made by the British Insulated Wire Company, Limited, on their usual paper insulated and lead-covered pattern. Each cable consists of two concentric stranded conductors. We may note here that with a two-phase transmission system any cable may be used for either phase, the two phases are entirely independent, and the whole of the existing single-phase network can be utilised just as it stands, while the outer can be earthed with safety and advantage; whereas on the three-

any men of the engine room staff at will, and that by doing

capable of accurate expression in a few words.

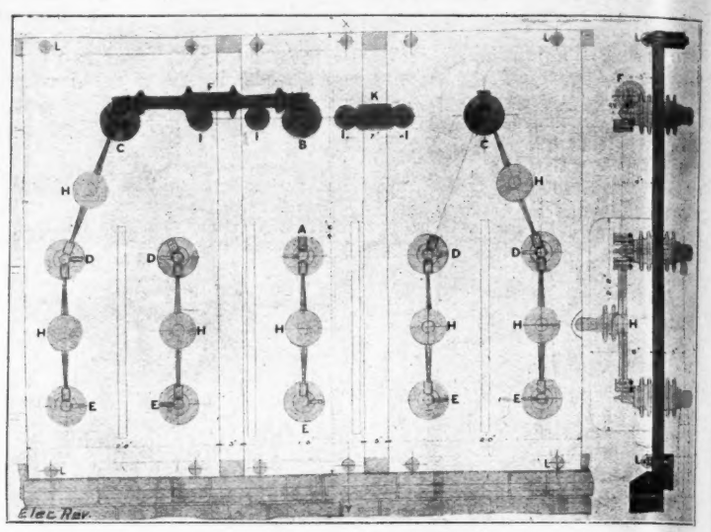
phase system each main must have three cores, insulated from one another and from earth; a breakdown in any one phase involves all three, and owing to the inter-dependence of the phases, balancing difficulties are even more troublesome than with a "three-wire" system. It will be seen, therefore, that the Metropolitan Company was well advised in adopting a two-phase system, which, as the company justly claims, will "work in conjunction with all known systems of supply," whether alternating or, with rotary converters, direct.

The cables are laid in a five-way cast-iron conduit, 20 inches × 6 inches, which is capable of accommodating five additional cables when required. The conduit is laid under the towing path of the Grand Junction canal as far as Amberley Road sub-station. Up to this point the cross-section of each conductor is 0·2516 square inch, from Amberley Road to Norfolk Crescent Mews sub-station it is 0·1909 square inch, and from there to Rathbone Place it is 0·0973 square inch.

At the sub-stations, step-down transformers of 100 KW. each are installed to the number of 30. These are, like the step-up transformers, of the Berry type, made by the British Electric Transformer Manufacturing Company, Limited, and transform from 10,000 to 1,000 volts; they are 2 feet 2 inches in diameter and 4 feet high, and weigh about 25 cwt. each. The mid-point of the secondary winding is earthed, and no earth shields

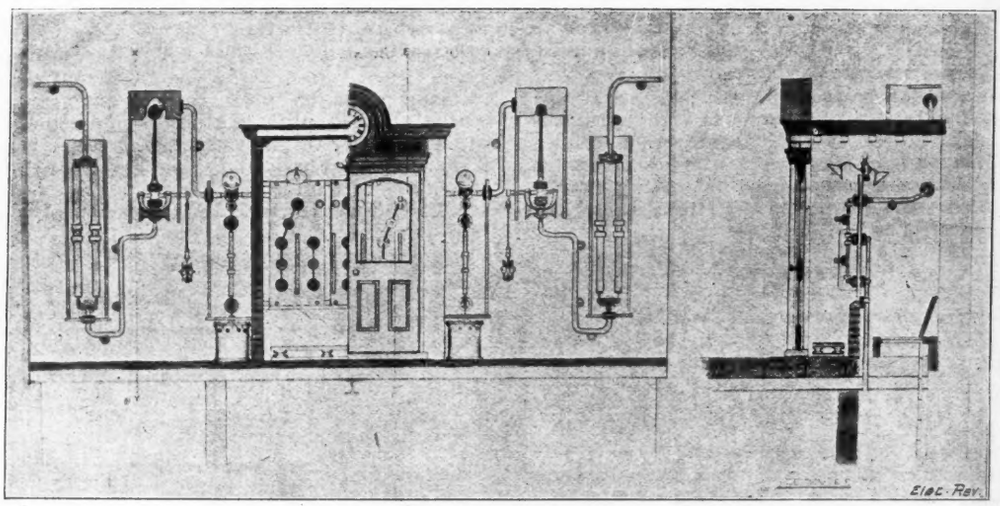
four additional transformers of the same size and make, and 20 of 50 KW. each, are at present on order.

A special type of disconnecting box, designed by Mr.



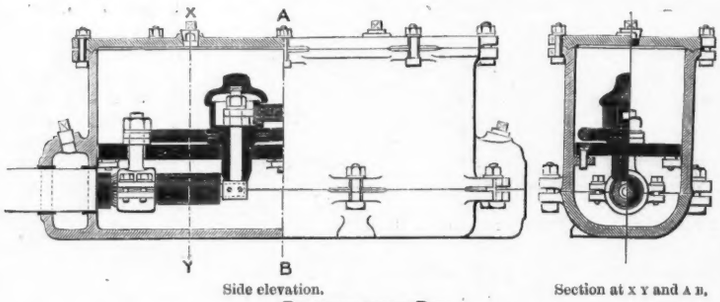
Switchboard for Extra High Tension Mains in Sub-station

Partridge for use on the 10,000-volt mains, is shown in one of our views, which is practically self-explanatory. The



General Arrangement of Extra High Tension Apparatus in Sub-station.

or other devices are used; part of the winding is connected with a regulating switch giving a range of 120 volts in 12



Side elevation. Section at X Y and A B.

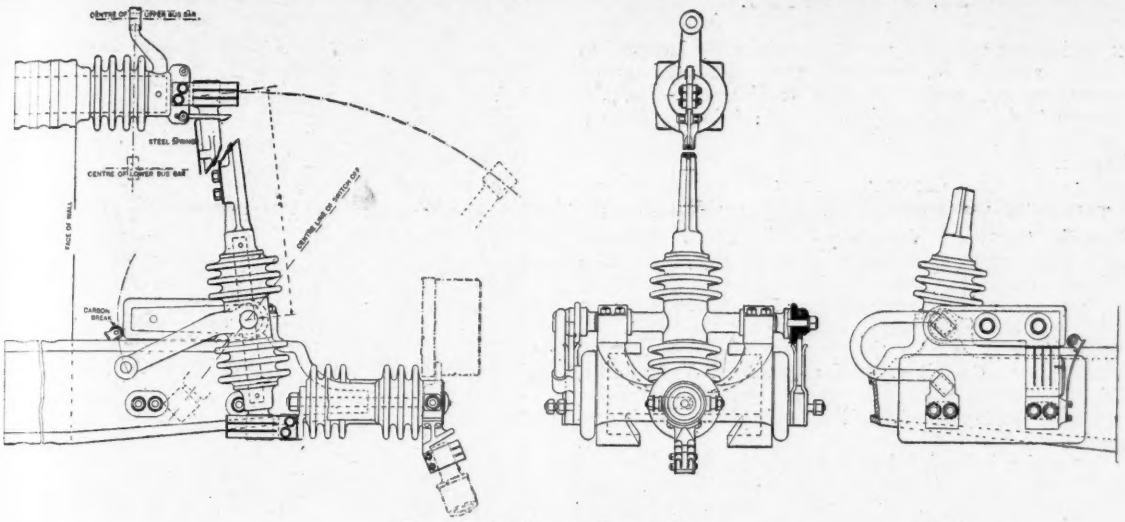
Disconnecting Box.

steps. Intermediate points are connected with a choking coil, so as neither to break the circuit nor to short circuit the transformer coils when operating the switch. Thirty-

insulating material is chiefly ebonite, special care being taken to thoroughly protect the inner conductor; the lower part of the box is filled with oil.

Detailed drawings are also given of the high pressure switch gear used in the main and sub-stations, also designed by Mr. Partridge, and which we have briefly described in connection with the step-up transformers. The construction of the switch is well seen in the figures. The insulation here also is chiefly of ebonite, with deeply corrugated surface to reduce surface leakage, and a long steel spring is provided to take the spark on opening the switch. An ammeter in the high pressure circuit is mounted on the switch, as shown, being supported entirely by the conductors. It will be noticed that the low pressure switch, which is operated together with the high pressure switch, is of the double-pole type, and closes before the latter; it is provided with carbon breaking pieces.

The arrangement of the controlling gear in a sub-station forms the subject of another of our views; the type of apparatus employed is generally similar to that at the generating station. The connections are made with the high pressure trunk mains by means of terminals and connecting bars, H H, mounted on three panels and enclosed in a locked compartment. The right-hand panel is devoted to the blue phase, the left hand to the red, while the spare cable occupies the middle panel. The mains from Willesden are connected to the middle horizontal row of terminals, D D and

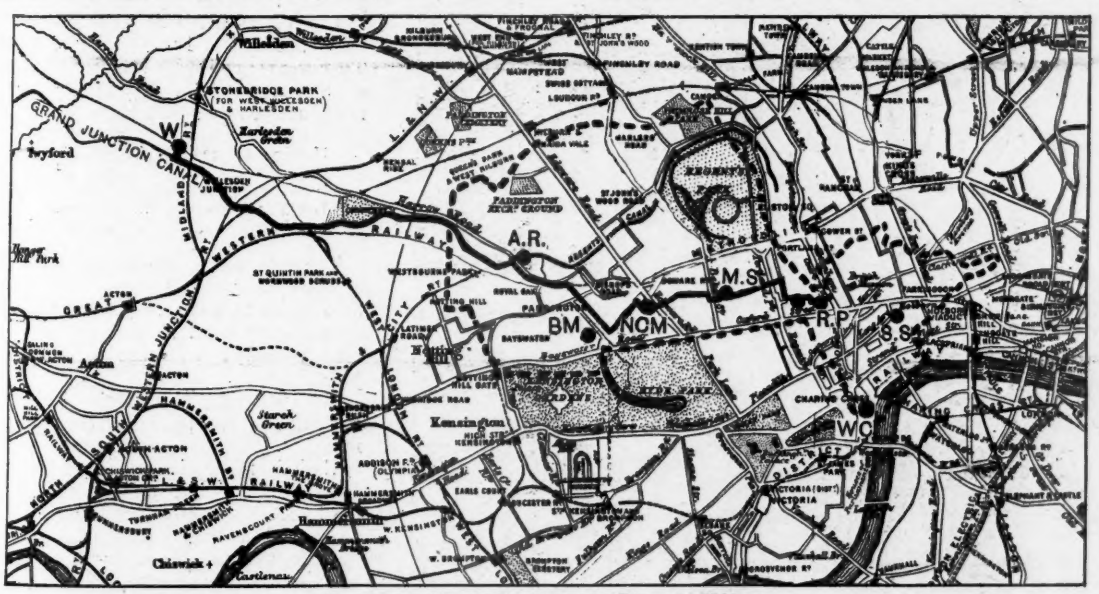


Extra High Tension Switch Gear.

A, those to London to the bottom row, E E, and the sub-station bus bars to the two outermost terminals at the top, C C, which it will be seen can be coupled to either or both of the two Willesden terminals on their respective panels. The bus bar leads pass through fuse and switch gear, which is sufficiently clear in one of the figures.

A small "safety" transformer is provided for use when the spare cable is to be coupled to either side of the system. This is connected, one pole of the primary to the middle terminal, B, at the top of the centre panel, the other pole to the two small terminals, I I, on the same panel. The spare cable having been connected up at Willesden, a connector is inserted into the small terminals on one side of the board at the sub-station, say the blue, as at K in the figure; if the spare cable is connected to the blue phase at Willesden there is no appreciable current through the transformer, but should it have been connected with the red phase, the transformer forms a connection between the two phases, and the lamps light up. It is clear from the diagram that if care is taken that the lamps are alight when the connection is made, it is impossible to couple the spare cable to the wrong phase at the sub-station, for the test plug, K, is in the way of the bar connector, F, used for this purpose. The inner conductors alone are brought on the board, the outers being joined to a common earth bar at the bottom of the board.

It will be obvious, from the foregoing description and illustrations, that the great principle underlying the whole of the system is *reliability!* By the irony of fate, the elaborate precautions taken to ensure safety were of no avail last December; for the contractors who carried out the ironwork of the buildings and the steam piping were so late in delivery that they kept back the whole of the work, and Willesden could not relieve the overburdened generating stations in London until the middle of December, while the unavoidable interruptions of supply caused by the excessive demand gained for the company an unenviable notoriety in at least one district of its area. Now, however,



Map of the Company's Area and Route of Mains.

all that is over; the new order of things is firmly established, and we have no doubt but that in future the name of the Metropolitan Company will be synonymous with regularity and reliability of supply. The plans were prepared to the designs and the plant constructed to the specifications of Mr. Frank Bailey, M.Inst.C.E., whose ripe experience, gathered during his long connection with the Metropolitan and City of London Companies, enabled him to foresee every probable source of trouble and to provide for its antidote. The works were constructed under the superintendence of Mr.

E

R. R. Todd, now chief engineer to the company, and were completed with the assistance of Mr. C. A. Holbrow.

To these gentlemen, who afforded us every facility for the preparation of this article, as well as to certain of the contractors, we tender our best thanks for their kind assistance.

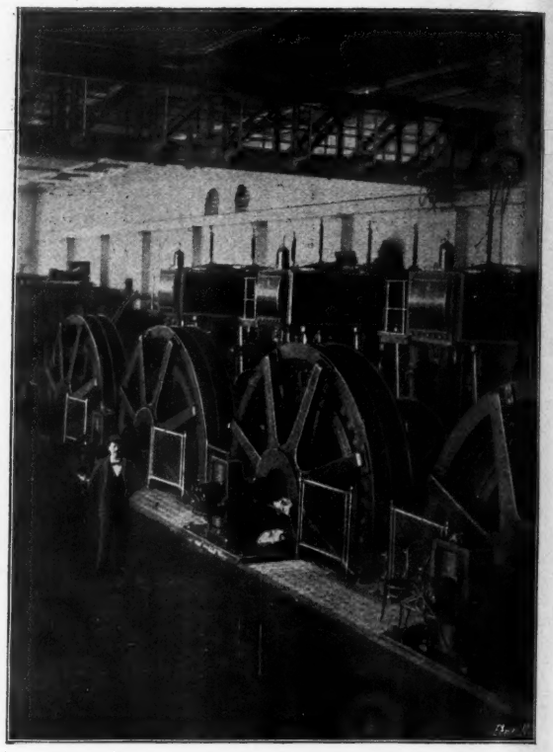
THE ELECTRIC LIGHTING OF ST. PETERSBURG.

In the last two years the use of electricity has increased to a great extent in St. Petersburg, three companies having erected stations, namely, Siemens & Halske, Helios, and Electricité et Hydraulique de Charleroi; below is given a description of the last-named company's central station and network.

Central Station.

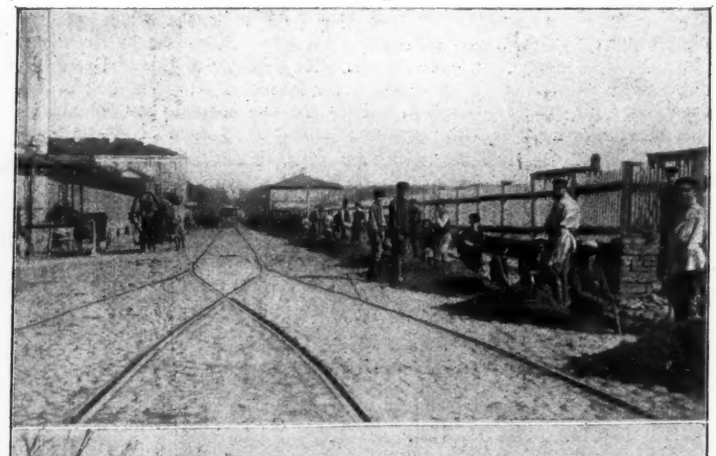
This covers about 8,900 square metres at the corner of the Fontanka Canal and Vvedensky Canal. The Fontanka is the principal means of navigation across the city; this greatly facilitates the transport of coal. The enormous quantity of water necessary for condensation (1,700 cubic metres per hour at full load) is taken directly from the canal. As regards situation, it is in the proximity of the commercial districts, viz., Gorochovaja, Nevsky Pros., Vosnesensky, Sadovaja, &c., these places being near the centre of the city on the south side of the River Neva (see plan of St. Petersburg).

The station is divided into two parts, one for boilers and the other for the alternators and engines; the former occupies space to the extent of 66 metres by 22, and the latter 66 metres by 24. Both are entirely separate, a brick wall



St. Petersburg Alternators.

Trenching at St. Petersburg.



Cable Laying at St. Petersburg.

reaching right to the roof, so preventing all coal dust from getting to the machines.

Owing to the annual rise of the canal, the boiler house is raised 1·20 metres above the level of the engine house, which is itself 3 metres above high water mark.

There are four chimney stacks, the internal diameter of each being 3·20 metres at the base, and their height from the ground 47 metres.

The boiler house is built to house 24 boilers, of which 19 are actually erected. They were supplied by Fitzner and Gamper of Sosnovice (Russia), and are of the multitubular type; they have

Heating surface	...	265 m²
Firing surface ...	...	4·20 m²
Number of tubes	...	156
Length of tubes	...	5·50 m.
Steam pressure...	...	12 atmospheres.

The water and steam reservoir is formed of two cylinders of 1 metre diameter and 5·90 metres in length, joined at the top by a cross pipe of 1·10 metres diameter in communication with the bank of small pipes.

The outlet is at the middle of the longitudinal reservoirs, and the feed pipe at the rear.

Each is fitted with an automatic stoker, distributing the coal on very inclined fire bars. At the bottom of these is a fireproof bricked arch, so mixing up and burning completely all gas products. This gives very satisfactory results, Newcastle coal being used in preference to Cardiff, which is generally used in electrical stations. The cinders are taken away underneath by means of trolleys run on rails.

Engine House.

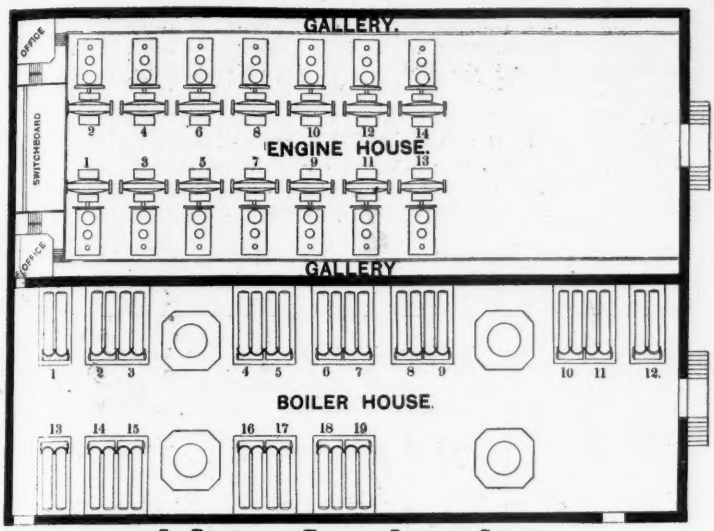
This is built to take 20 steam sets, 14 being actually erected.

The machines are ranged on each side, with the alternators towards the centre gangway. At the farther end from

lamps light up. It is clear from the diagram that if care is

The works were constructed under the superintendence of Mr. E

the main entrance, on an elevated platform, is the switchboard, raised 3 metres from the ground, the platform itself being 5 metres in width, extending the whole width from wall to wall. Two more platforms run the whole length of the station on a level with the cylinder tops, with a bridge tapped off for each, so as to allow for the facility of lubricating purposes. At each end of the switchboard is an



St Petersburg Electric Lighting Station.

office, one for the chief engineer, and the other for his assistants.

A 10-ton travelling overhead crane, of 24 metres in width, runs the whole length, and is worked by hand.

Under the engine room floor the space between the steam set foundations is utilised for steam and drain pipes, and readily accessible.

Engines.

Each is 500-h.p. effective, but is usually worked at 400 h.p. Nos. 1, 3, 5, 7 and 9 were built by Sachsenberg de Rosslan i/Anhalt, the others (2, 4, 6, 8, 10, 11, 12, 13 and 14) were turned out by the Maschinenhan-Actienge-Sellschaft de Nurnberg.

These two types are much alike, and only differ in detail of construction. They are vertical triple expansion, of the "drum stick" style. When tested they consumed 5·5 kilogrammes of steam per horse per hour, taking into account condensing.

Below are given the chief features of the Nurnberg engine:—

Diameter of high pressure cylinder ...	450 mm.
Diameter of intermediate pressure ...	715 ,,
Diameter of low pressure...	1,060 ,,
Diameter of shaft	220 ,,
Diameter of fly-wheel	3,000 ,,
Weight of fly-wheel	2,700 kg.
Initial pressure	11·5 atmospheres.
Loss at full load	4·5 per cent.
Piston stroke	550 mm.
Revolutions...	142.

A substantially built governor acts on the feed of the high pressure cylinder, which is commanded by a valve of the Rider type; for the other two cylinders they have the simple equilibrium plain slides.

Each machine has its own particular condenser; this gives important advantages in point of view of the running and putting in step. The air pump is worked from the crosshead of the intermediate, and is situated below the engine room floor. In case of necessity a valve is provided for exhausting to atmosphere.

The cylinders are jacketed. All moving parts receive oil by a system of pipes emanating from a general reservoir. Pump greasers do the lubricating of the cylinders.

The working of these engines is very easy, the parts in motion being easily accessible during running, and incandescent lamps lighting up everything clearly.

Alternators.

The alternators were furnished by Brown, Boveri & Cie., of Baden, and give a normal output of 175 amperes at 200 volts, and at a periodicity of 42·5 per second.

They are coupled direct on the engine shaft.

The stationary armature comprises a laminated iron ring, pierced with slots, in which are fixed the induction coils. The laminations are divided into five sections, leaving between them grooves of ½ centimetre for ventilation. They are held firmly by built-in bolsters. The two halves are supported by pieces which rest on the foundation, presenting a considerable binding surface (about 1 metre by 2·25). The supporting of the circular ring is effected by a double spider, formed of six spokes radiating from collars on the bearing.

The inductive circuit comprises 36 coils, formed of seven turns each, and connected in series. The conductors are insulated in micanite tubes.

The movable part of the alternator is formed of a fly-wheel of two pieces, on which are mounted the 36 pole-pieces. These are wound on bronze bobbins. They are each formed of four layers of 32 turns of wire. They receive current from brushes in contact with two collecting rings. The polar pieces are of soft iron.

Each alternator has its own exciter mounted on the engine and alternator shaft, and gives a normal exciting current of 45 amperes at 200 volts.

(To be continued.)

NEW WIRE FOR TROLLEY AND OTHER PURPOSES.

By F. Z. Maguire.

With the ever increasing use of the telephone, telegraph, and trolley the need of a material able to stand under all sorts of trying conditions, to endure extraordinary strains without yielding, has become apparent to many engineers. Up to the present time hard-drawing copper and composite wires of copper and steel have been the main reliance in practice. Phono-electric wire has been recently brought forward as an improvement by the concern which first made and gave hard-drawn copper its name. There is not any method of hardening pure copper more effective than the process of hard drawing, and Phono-Electric wire is offered as being capable of standing greater strains and possessing other properties new and desirable to engineers.

The following tests show the fundamental properties of the wire:—

Table I.—Tenacity and Electrical Properties of Phono-Electric Wire.

Number B. & S. gauge.	Diameter in mils.	Breaking weight pound.	Tensile strength. Pounds per square inch.	Resistance per 1,000 feet in international ohms 75° F.
0000	460	11,460	68,780	·12
000	409 6	9,140	69,180	·1518
00	364·8	7,400	70,620	·1929
0	324·9	6,300	75.830	·2423
1	289·3	5,250	79,670	·3077
2	257·6	4,180	80,000	·3868
3	229·4	3,360	81,080	·4878
4	204·3	2,700	81,150	·6150
5	181·9	2,080	81,190	·7758
6	162	1 680	81,280	·9771
7	144·3	1,350	82,380	1·233
8	128·5	1,075	82,700	1·555
9	114·4	850	82,460	1·961
10	101 9	685	83,810	2 472
11	90·74	545	84,060	3 109
12	80·81	420	83,700	3·932
13	71·96	340	83,390	4 957
14	64 98	270	83,710	6·251
15	57·07	220	85,210	7 86
16	50·82	180	85,500	9 81
17	45 26	135	84,670	12 6
18	40·3	107	84,800	15 95

These results indicate the new wire to be more than twice as strong as annealed copper and nearly 50 per cent. stronger than hard-drawn copper. It is also claimed that the good properties are permanent.

The strength of hard-drawn copper is only skin deep, and once the skin is injured, as is the case frequently in trolley use, &c., the great value of the wire is gone, because the interior of the wire is *soft* copper. The hardened skin is $\frac{1}{32}$ of an inch, and it is claimed that most of the value is in the outer half of this layer. In proof of the facts stated, Table II. represents the results of chemically removing successive strata from the surface of hard-drawn copper trolley wire and measuring the tensile strength of the remaining core. Samples of Phono-Electric wire were treated in a similar manner to eliminate from it any characteristics which might be charged to mechanical treatment during drawing, and then tested.

The results are as follows :—

Table II.—Skin Effect Due to Hard-drawing Copper Wire.

——	No. Brown and Sharpe gauge.	Original diameter. Mils.	Thickness of skin removed in mils. from hard-drawn copper and Phono-Electric wires of same size.						
Wire ... ... Hard-drawn copper	00	365	12·5	17·5	22·5	27·5	32·5	37·5	92·5
Tensile strength Pounds per square inch ... Phono-Electric	...	52,000	51,400	48,500	41,500	36,725	34,500	34,600	34,600
Tensile strength Pounds per square inch ...	...	73,500	73,500	73,500	73,460	73,480	73,500	73,480	73,480

This table indicates that removing $\frac{1}{64}$ inch of the surface of hard-drawn copper wire noticeably lowers the tensile strength, while $\frac{1}{32}$ inch below the surface there is practically nothing left but soft copper.

The following table shows a comparison between the electric limits of hard-drawn copper and the Phono-Electric wire :—

Table III.—Elastic Limit.

Wire.	Numbers B. and S. gauge.	Diameter in mils.	Tensile strength. Pounds per square inch.	Elastic limit. Pounds per square inch.
Hard-drawn copper	00	346·8	52,000	41,775
Phono-Electric ...	00	364·8	73,500	57,860
Hard-drawn copper	0	324·9	54,000	39,645
Phono-Electric ...	0	324·9	76,500	55,195

In electric railway work the trolley wire not only has to stand the mechanical strain of friction and hard pounding, but it constantly happens that the passage of the trolley wheel is accompanied by small electric arcs set up between wheel and wire. These burn and roughen the surfaces, so that the action quickly goes from bad to worse. It both burns and scars the trolley wire, and anneals parts of its surface. If the wire is ordinary hard-drawn copper, the hardened skin is destroyed, and the wire thus weakened, rapidly succumbs. This is the secret of the frequent breaking of trolley wires at curves where there is heavy surface arcing being often established by the flange of the trolley wheel. It is claimed that Phono-Electric wire is free from this serious difficulty for two reasons—it does not maintain an arc readily, and it does not anneal. Its fusing point being high and also free from constituents easily vaporised, it does not furnish enough metallic vapour to keep an arc going.

Some special experiments with hard-drawn copper and "Phono-Electric" wire were carried out to show the annealing effect of arcing. Samples of No. 00 and No. 0 wire of each kind were exposed 10 times during the space of 20 minutes to brief arcing from the surface, with the voltage kept constant, and all the samples treated alike as nearly as practicable. The samples were then carefully measured as to their tensile strength.

Table IV.—Weakening of Wires by Arcing.

Wire.	Numbers B. and S. gauge.	Diameter in mils.	Original tensile strength. Pounds per square inch.	Tensile strength after arcing. Pounds per square inch.
Hard-drawn copper	00	364·8	52,000	43,680
Phono-Electric ...	00	364·8	73,500	73,450
Hard-drawn copper	0	324·9	54,000	46,440
Phono-Electric ...	0	324·9	76,500	76,430

It is also claimed that Phono-Electric wire will resist weather, salt-fogs, and the action of corrosive fumes far better than hard-drawn copper, and the makers invite the most rigid tests on the part of engineers.

CURRENT SPECIFICATIONS.

IV.—NORTHUMBERLAND COUNTY ASYLUM ELECTRIC LIGHTING.

Summary.

System.—Two-wire with 200-volt glow lamps.

Type of Boilers.—Lancashire type.

Size and Number of Boilers.—Two, each to be 28 feet long and 6 feet 9 inches diameter.

Output of Steam Dynamos.—20 KW., alternative offers being invited for 24-KW sets.

Number and Type of Steam Dynamos.—Three sets, each to give 20 KW. 200 volts with 110 lbs. steam pressure working non-condensing with a back pressure not exceeding 5 lbs. square inch. Type and speed of engine optional.

Output of Battery.—110 cells, each with a normal discharge of 45 amperes for 9 hours, or 150 amperes for 2 hours without terminal voltage falling below 1·8 volts.

Output of Motor Booster.—One motor booster to be supplied, output 50 amperes at from 10 to 80 volts, speed not to exceed 1,000 revolutions per minute.

Total Number of Lamps to be Wired.—1,066 points on assumption that all are 16 C.P.

Conditions of Wiring.—To be in accordance with the Wiring Rules issued by the Institution of Electrical Engineers, July, 1897.

Time of Completion.—To be stated by tenderers.

Penalty for Late Delivery.—£5 per day.

Stipulations as to Wages paid to Workmen.—None.

Stipulations as to Removal of Foremen.—Unsatisfactory, see comments.

Arbitration.—Unsatisfactory—see comments.

Date for Receipt of Tenders.—April 16th, 1900.

This specification has been prepared by Mr. A. A. Campbell Swinton, M.I.C.E., and is the first dealt with in this series where a complete electric lighting installation is

required. One price has to be given for the whole of the work, and the contractor must take undivided responsibility for the satisfactory completion of the entire undertaking.

There are in all 1,066 points in the various buildings to wire, and although a number of these will probably be of 8 C.P. size, the wiring is to be suitable for 16 C.P. lamps throughout. We consider this a wise precaution, and as the lamp voltage is 200 volts, except in the feeder and sub-feeder mains, the sizes of the distributing wires will not be unduly increased, as in many cases where wiring is arranged for 8 C.P. 200-volt lamps the sizes of the conductors are determined by the minimum sizes advisable for mechanical reasons rather than by drop in voltage considerations.

All contractors who are desirous of uniformity in wiring requirements will be glad to note that by paragraph 6 in the general conditions :—

The whole of the work, plant, and apparatus to be of the best and most substantial description and best finish; to comply in all respects with the rules of the fire insurance offices with which the buildings are insured, *and with the general rules for wiring of the Institution of Electrical Engineers*, issued July, 1897, and must be carried out in all respects to the satisfaction of the engineer.

The placing of the Institution rules in the forefront is a step in advance, as it tends to hasten the time when compliance with these regulations will be considered the generally acknowledged test of satisfactory work.

There are several of the clauses in the general conditions to which exception may fairly be taken, particularly in regard to the power given to the consulting engineer and the asylum authorities in regard to the contractor's workpeople.

Having regard to the fact that the asylum will be inhabited during the time that the work is to be carried out, we should be willing to concede to the medical superintendent the power to ask for the *removal* of any workman, whose presence he deemed for special assigned reasons inadvisable, but Clause 22 goes farther than this, for it states :—

To secure the due care and protection of the patients who may be under treatment in the said asylum during the progress of the work, the contractor, his servants and workmen, shall pay strict attention and conform to the orders, rules and directions which the medical superintendent of the said asylum may lay down during the progress of the work as to access or ingress and egress to or from any portions of the asylum buildings and premises used or occupied by or in which patients may be employed, and *the contractor shall, on the requisition in writing of the said medical superintendent of the asylum, forthwith discharge any workman, servant, or labourer* employed by him *without reason assigned*, and shall not again employ such person on the work except with the consent of the Committee of Visitors, testified in writing, under the hand of the clerk of such committee.

The power to demand the *discharge* of any workman *without assigning any reason* for so doing, is not, we consider, fair, and we advise that exception be taken to this when tendering.

In Clause 12 the engineer claims power not only to demand the *removal and discharge* of any workman or foreman, but, under certain circumstances, the right to engage other workmen or men, who shall be considered the contractor's servants. The clause reads thus :—

The contractor will, at his own expense, during the progress of the works, keep and employ a competent foreman in each department of labour as may be directed, and also a principal foreman or superintendent of the works, and every such foreman (including the principal foreman or superintendent) shall constantly attend at the works during work hours until the works shall be completed. And *the contractor will* at all times during the progress of the works *immediately remove and discharge* and *will not re-engage* any such foreman as aforesaid, or any of the workmen or labourers engaged in the works whom *the engineer*, whose *requisition* shall be *final, shall, in writing, require to be removed or discharged*, and in default thereof, the engineer may take such steps as he may think proper to prevent the employment or continuance of such person on the premises; and *if the contractor shall fail at any time to provide any such foreman* (including such principal foreman) or any workman *required by the engineer*, whose *requisition* shall be *final, to be employed within twelve hours after notice from the engineer requiring him so to do*, then *the engineer may provide such foreman* or workman, and *all expenses incurred by him in so doing shall be borne and paid by the contractor*, and *any foreman* or *workman thus provided by the engineer shall be the agent or servant of the contractor*.

This power *might* be used in a very unfair manner, and is a direct infringement of the right of private contract on the part alike of contractor and employé. The principle involved should be protested against, but waiving that point for the moment, the allowance of *12 hours* to the contractor in their busy time to find a foreman who shall be acceptable to the engineer, will appeal to all as exceedingly unjust.

It will be noticed that in Clause 12 the phrase "*whose requisition shall be final*," used in relation to the engineer, occurs twice. The same absolute power is demanded in several other places, particularly in Clause 16, where we find :—

If *the engineer, whose decision shall be final*, shall consider any part of the works to have been executed otherwise than in the most workmanlike manner, or than in accordance with the terms hereof, the contractor will, upon being required to do so by the engineer, forthwith pull down and remove the same and will substitute other works therefore to the satisfaction of the engineer, and if the contractor shall fail within such time as the engineer may think reasonable to carry out such pulling down, removal and substitution, the engineer may employ other workmen so to do, and the costs thereby incurred shall be borne by the contractor.

And in the final arbitration clause, these points are expressly withdrawn from its operation, so that for practical purposes the engineer is *counsel for his employer* and *judge of his own case* at the same time. The so-called arbitration clause is worded as below, and we strongly recommend that tenderers propose to substitute for it the usual standard clause, where *all matters of possible dispute* are held to be subject to submission to its ruling.

If any dispute or difference shall arise between the committee or the engineer and the contractor upon any point or matter concerning or arising out of these presents, *not being a point or matter upon or as to which the decision, requisition, direction, or certificate of the engineer is hereinbefore declared to be final*, such difference or dispute shall be determined by an umpire to be mutually agreed upon between the committee and the contractor, or should no umpire be mutually agreed upon within a week after either party shall be required in writing by the other party to name an umpire, then by an umpire to be named by the president for the time being of the Institution of Electrical Engineers, and the decision of the umpire thus appointed shall be final, and such reference shall as to the mode and consequences thereof and in all other respects conform to the provisions applicable to a reference to a single arbitrator under the Arbitration Act, 1889, or any then subsisting statutory modification thereof.

In conclusion, we think that a rather invidious distinction is made in the following sentences which form part of Clause 20 dealing with penalty :—

Provided also that in case at any time during the progress of the works any part thereof shall be damaged by fire, or *there shall be a general strike of workmen affecting any of the electrical or engineering trades, as distinguished from a strike of workmen against the contractor or any person employed on the works*, the contractor shall be allowed such further time for the completion of the works as the engineer shall certify to be fair and reasonable, and there shall be a corresponding postponement of the day at which the said damage of £5 per day would have otherwise commenced.

A Vacuum Electroscope.—It is a matter of considerable interest, from a theoretical point of view, to ascertain the nature of electrostatic actions in an absolute vacuum. With the improved apparatus now available, a much more perfect vacuum can be produced than was the case some years ago. Pflaum (*Ann. der Physik, &c.*, p. 290, 1900) has constructed an electroscope in which the leaves were of aluminium foil and were enclosed in a pear-shaped glass bulb exhausted to a very high vacuum. The vacuum was by no means perfect, but was sufficiently good to show that a vacuum is probably a perfect insulator, and all electrostatic effects take place, though in an intensified degree. Two platinum wires were fused into the lower part of the bulb, between the ends of which was a spark gap of 0·4 mm. When a discharge was sent between these two wires from a 40 mm. induction coil, the leaves of the electroscope were violently affected. If an electrified body is brought near the knob of the electroscope, the leaves diverge as in the ordinary electroscope, but when the body is removed the leaves come together, and then permanently diverge. The final effect is considered to be due to negative electricity discharged from the leaves on to the inner wall of the tube. If electric oscillations are produced in the neighbourhood of the electroscope, the leaves are thrown into violent vibration. If the oscillations are produced by an induction coil or a Tesla coil, the vibrations gradually pass into a permanent divergence. In the first case the permanent charge is of the same sign as the first discharge of the coil; in the second case, the sign of the charge is negative when the Tesla coil is near the electroscope, and positive when the coil is distant.

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.*

Whatever may be said of the War Office, it will scarcely be doubted that the Admiralty deserves the thanks of the nation during these troublous times, inasmuch as the unceasing care which it has bestowed upon the Navy of late years has brought about such a condition of efficiency and readiness, that foreign nations who wish England ill have been obliged to pause, however desirous they may have been of taking advantage of her present difficulties in South Africa. The nation has demanded a good Navy, and the Naval authorities having formulated their requirements, have laid the vast engineering experience of the country under tribute to meet these requirements, and with the most gratifying results; for to-day the English Navy is not only the most formidable in the world, but the methods followed in its development constitute a guide and pattern to all other navies.

Scarcely any branch of science has contributed more to the efficiency of our Navy in recent years than electrical engineering. The shipbuilders, the engineers, and the ordnance contractors are indebted to electricity to an extent that is difficult to estimate. So much has been accomplished that a modern ship of war is really a compendium of almost all that has been accomplished in the application of electricity from lighting and power distribution to the use of the Röntgen rays; yet though so much has already been done, certain developments are imminent, which, in many departments, quite overshadow present-day practice. In view of this, Mr. C. E. Grove read last night an exhaustive paper on the general electrical equipment of men-of-war, which covered the ground most thoroughly, and will constitute a reference on the subject for some time to come. The paper will comprise some 72 pages of the *Proceedings*, and is fully illustrated; we are obliged therefore to resort to the following condensation:—

Part I.—General Equipment.

Dynamos.

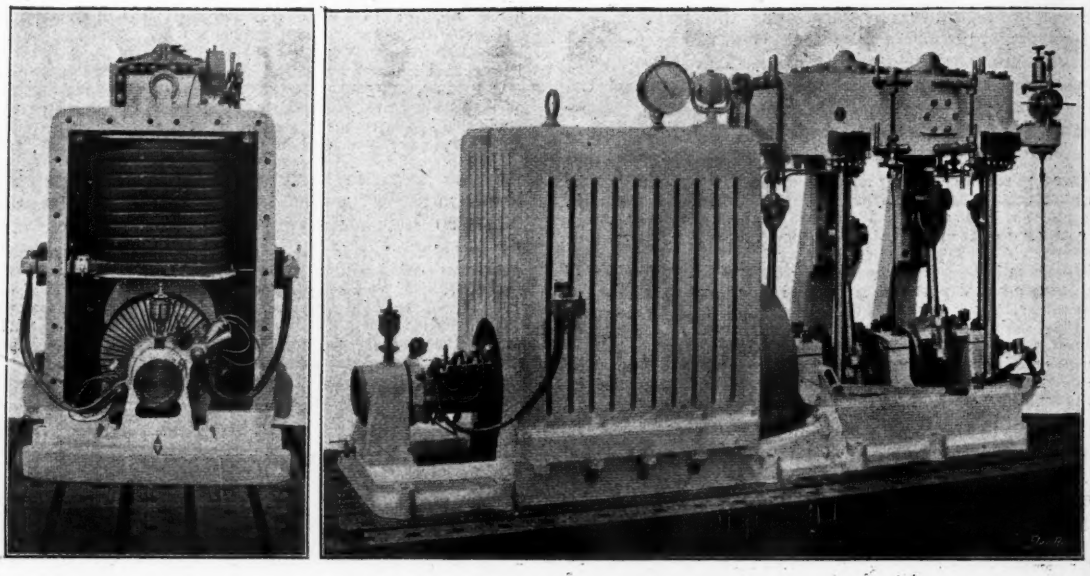
The history of the dynamo on board a man-of-war dates from 1876, when a Wilde alternate current magneto-machine, belt-driven, was installed to work a searchlight projector. Then came the continuous current Gramme machine, which was superseded in due course by the two-pole drum-wound direct-coupled compound steam dynamo, which, until about 1895, was the standard in our Navy.

The size of unit varies by steps of 100 amperes from a machine giving 100 amperes in the case of small vessels to the machine of 600 amperes now used in all modern battleships and large cruisers. The standard voltage is 80 in all cases, a compromise between the pressure required for searchlights and that giving the best efficiency in the ordinary light circuits; but it is felt that this low voltage is becoming increasingly inconvenient. The standard speed for all sized machines beyond 200 amperes is 300—320 revolutions per minute; in the smallest sets the speeds sometimes attain 500 revolutions, and, with forced lubrication, this speed is now being used for the larger sizes.

The Admiralty specifications insist upon a low steam consumption in the engines working the dynamos, and they require that after a six hours' run at full load the temperature of the machine shall not exceed 80° F. above that of the surrounding atmosphere.

Ironclad machines are often employed owing to disturbances of the compass readings which have been observed to be due to the direct influence of the dynamos. This has entailed difficulties in designing to a minimum weight and in providing adequate ventilation. In figs. 1 and 2 is shown such a machine, designed by Mr. Grove, in which thorough ventilation is secured by the device of coring slots through the bottom, sides, and ends of the magnet castings.

The ironclad type is now being superseded by an open four or six-pole machine, which, on the whole, provides the best combination of good ventilation, minimum external leakage, and accessibility of parts. Fig. 3 shows a recent 600-ampere Admiralty set by Messrs. W. H. Allen & Co.



Figs. 1 and 2.—Ironclad Dynamo (Thames Ironworks).

Steam engines of the open type are usually employed for dynamo driving, and must be of strong construction, as they have to work with the high-pressure steam from Belleville boilers (275—300 lbs. per square inch), though with cylinder areas large enough to permit their nominal full output at 150—200 lbs. pressure. Other essentials are ample bearing surfaces, thorough lubrication, and ability to get rid of the large volumes of water which come on with the steam when auxiliaries on the same range of steam pipes are started.

Switchboards.

The standard British Admiralty pattern switchboard consists of a slate or slates carrying horizontally upon them a series of omnibus bars connected severally with the positive and negative terminals of the dynamos, and bridging over these a series of vertical slotted bars leading through fuses to the circuits, and carrying sliding contact plugs, which can be pressed down so as to make contact on the top and sides of the omnibus bars, being locked in the "on" position by a spring handle, and maintained in the "off" position

* Condensed from a paper read by Mr. C. E. Grove at the Institution of Electrical Engineers, April 5th.

by the action of an internal spiral spring, which also gives a quick break. All the current-carrying parts are on its face, and it is fairly compact; but the method of making contact leaves much to be desired, and the switch parts consist of a number of components, which give complexity and add to the cost of maintenance.

In other navies and in many ocean liners parallel working is now in successful operation; this is a distinct advance upon our position. As an example, the U.S. Navy standard switchboard is shown in fig. 4, with its dynamo bars vertical and circuit connections horizontal. The *Kearsage* and *Kentucky*, which are fitted with this switchboard, carry seven 50-KW. dynamos each. Each dynamo bar is surmounted by its ammeter and main throw-over switch. A panel at one end contains the instruments used in common by all the dynamos. The field terminals of the machines are brought to the switchboard, where they may be connected either for self or separate excitation. Equaliser switches are fitted on a separate panel in another part of the room. From the main board feeders are run to these three-wire main distributing boards, located respectively forward, aft and amidships, from which the several power, searchlight and lighting circuits are run. Each of these boards receives from the main generator board five cables—a pair of "outers" for lighting, a similar pair for power and a common neutral. Four sub-distribution boards for groups of motors are supplied from the main distribution boards. A circuit breaker and a short-circuiting switch for the series winding are carried by each generator on the terminal board from which its main cables are led. Although the electrical principles involved in this scheme seem in the main right, the multiplication of switchboards is not a good feature for installations on board a ship.

(To be continued.)

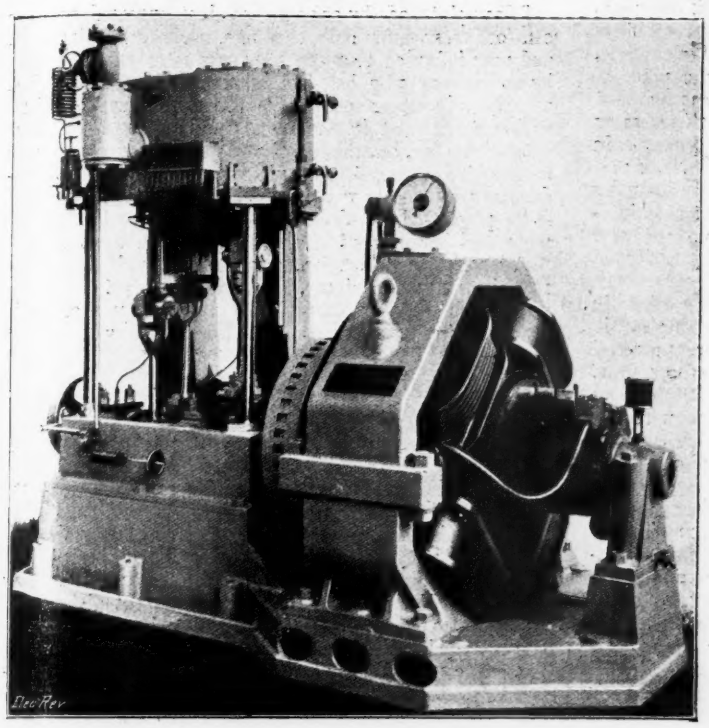


Fig. 3.—Modern Admiralty Multipolar Generator (W. H. Allen, Son & Co.)

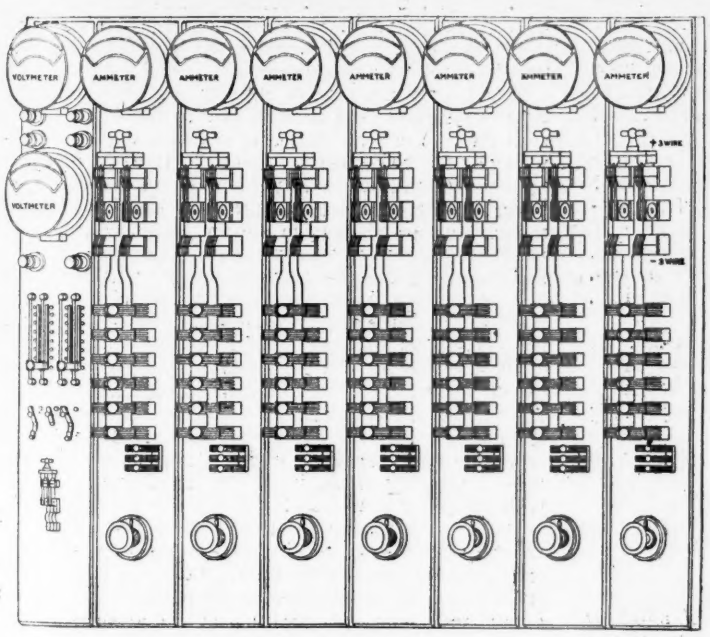


Fig. 4.

REVIEW.

Lubrication and Lubricants. By Leonard Archbutt and R. Mountford Deeley. London: Charles Griffin & Co. 1900.

The authors of this book are both practical men on the Midland Railway, and have produced a very useful and valuable book, though there are many practical points left unconsidered. Thus, not a dozen lines are given to the question of emulsions, whereas we are sure many practical engineers must have experienced the lack of some explanation of this phenomenon.

The whole question of lubrication has been entirely changed since the introduction of mineral oils. These oils are cheap, and they are not liable to acidity if properly washed after refining; but, at the same time, they have a certain lack of body or of the quality best rendered by the term greasiness, and undoubtedly are not so efficient, as lubricants, as are many animal and vegetable oils. The trouble with oils generally is that in the oil trade, the whole treatment and refining of oils and the manufacture of greases are a curious compound of scientific chemical knowledge and trade secrets of the kind which enables a seller, if he have once found a suitable oil mixture to fulfil a special service, to demand a double price for the mixture of a couple of oils in themselves cheap.

Oils are so difficult to distinguish by anyone not specially experienced in them, that these secret arts and hidden mysteries rarely become known to ordinary users, and only to them after careful trial and strict examination. Even the analytical chemist of experience often finds it difficult to determine what an oil really is. Blowing, deblooming, and other operations are performed on oils, which are caused thereby to assume different degrees of viscosity, and to assume a complexion foreign to them. These variations are almost entirely made for purposes of adulteration, and not because the user of the oil may obtain a benefit; the oil trade generally suffers in reputation thereby, and the oil traveller is looked upon as a nuisance. In the book before us very full information is afforded upon every possible oil, with tables of specific gravity, freezing or setting points, viscosity, &c.

The lack of oiliness in mineral oils has naturally led to much compounding of these oils with organic oils for the

purpose of enabling films of sufficient stability to be formed. The authors state that these thickened oils contain soaps, which are supposed to act by increasing the viscosity, but may, it is thought, have the same effect on mineral oils as upon water, *i.e.*, they may cause the formation of thick lubricating films instead of thin ones.

The question of surface tension of liquids exercises a marked influence on lubrication. Thus oil will always shrink away from a heated spot and leave it clean, because it is drawn away by the surface tension of the cooler oil films surrounding the heated place, any oil present on which will, when heated, lose its tension, and recede to the point of greatest tension. Thus defective lubrication causing heat may rapidly intensify its own defectiveness. Needless to say, the use of mineral oils has caused great changes in mechanical engineering, or we should rather say, has permitted such changes. We need only mention cylinder lubrication with high pressure or superheated steam to indicate the changes wrought by mineral oils, as compared with the impossible old tallow, which decomposed both itself and the cast-iron which it professed to lubricate.

American engineers have noted with surprise that in England gun-metal bearings are successful where they fail in America. Is not this probably due to the more universal use of mineral oils in America?—for, as the authors state, white metal enables lubricants to be used which are deficient in the oiliness of the more costly fatty oils which were not so early displaced from use in England. Now that mineral oils are growing more and more to be used, so also we find white metal becoming more common every day.

Testing machines are described and illustrated in Chapter 9. These are mostly of the familiar pendulum class, or similar thereto. Chapter 10 deals with the design and lubrication of bearings, and contains a good list of white metal compositions, and the gist of Tower's results, showing the evil of drilling a bearing at the points of greatest pressure, whereby an oil can escape from its duty. The drilled hole serves simply as a safety or escape valve, and is a decided mistake, but Tower's results do not seem to have found their way into practice. Oiling chains and rings are illustrated. On the whole this chapter is good, but the subject of oil spray chambers is dismissed with very few words, as though it were the simplest matter in the world to lubricate the crank chamber of an enclosed engine, whereas these crank chambers have ever been a nuisance, and practical men know that extraordinary difficulties may be experienced, that the subject of closed chamber lubrication is not so simple as our authors state, and that something more than castor oil or pure mineral oil and water may be required.

Is it not an error to describe the grease for protecting polished steel surfaces as a mixture of white lead and tallow? Is not the correct mixture lime and tallow? both for cheapness and efficiency.

For those who wish to make a real study of lubrication, we can recommend, on the whole, no better book than this. The authors have made liberal use of the best authorities, and have written well and clearly.

The subject of lubrication is of immense importance. It is not one which begins and ends with the price per gallon of the oil. It is one very closely connected with the rate of shrinkage of the coal pile, and is, moreover, very closely wrapped up with the bill for repairs.

CORRESPONDENCE.

Test of a Ventilating Fan.

Your issue of 23rd ult. contained the results of a test by the Sun Fan Company, and having had opportunities at times of testing other fans, interest in the subject led me to look into the figures, which appear to be based upon an error of observation, either in the quantity of air or in the power expended.

At one point, viz., through the fan itself, the air must have had a velocity of at least 3,170 feet per minute. This would represent a water gauge of something like $\frac{3}{4}$ inch. Suppose we take it as $\frac{1}{2}$ inch, the equivalent resistance is 2·6 lbs. per square foot, or a total resistance of 73 lbs. over the area of the fan circle, so that the work done would be 3,170 × 73, or 231,000 foot-pounds per minute. This is equivalent to 7 H.P., and if the efficiency of the fan were, say, 70 per cent., the necessary power to drive it would be 10 H.P. This does not agree with the amount given as absorbed in the test, which was 5 H.P. only, and it certainly looks as if some important error had been overlooked by the experimenter.

Centrifugal.

March 27th, 1900.

[The point made by our correspondent appeared to us to call for investigation; we, therefore, made further inquiries, and were informed that the tests were most carefully made by an engineer who has had great experience in this line, and who was acting on behalf of intending buyers. Water gauges were placed in the ducts on both feed and delivery sides of the fan, but the fall of pressure was found to be very slight. To develop 10 H.P. was impossible under the conditions, as the motor would have been automatically cut out if the power had exceeded 7 H.P.—in which the losses in the motor and belting are included. A further and more recent test, made on a 4 feet fan, gave 20,000 cubic feet of air moved per H.P. per minute, a still higher figure!

We shall probably refer to this subject again shortly; in the meantime, we express no opinion one way or the other.—Eds. Elec. Rev.]

The Hire-Wire System.

I am obliged to you for the comments on mine of last week concerning the above subject. I need not repeat my remarks. The points I raised were left untouched. That the word "free" is a misnomer I am willing to admit. I never said anything in defence of the term. I know that the largest company in existence in that line of business has deleted the word from its name. Your remarks are beside the point. You make a deliberate statement about house wiring. I ask if you mind explaining how statement is substantiated. Your reply is to the effect that free wiring is a misnomer. You will pardon me for not seeing the connection between question and reply. You gratuitously made statements calculated to do harm to a system which is largely on the increase—which is in most stations, if not in all where introduced, having most beneficial results. This is quite true. I can, if required, bring opinions of engineers of both companies and local bodies who are familiar with "free wirers and their ways," and they will not utter ridiculous twaddle about "many agreements."

That you are in a state of the densest ignorance concerning this system of work is shown by your questioning remark *re* fittings. You "are curious to know what profit the free-wiring agency makes out of fittings." It will doubtless be news to you that, in over 75 per cent. of the installations of "free" wiring, no fittings whatever are bought by the customer. In cases where there are purchases made, these are usually for one or two extra-well furnished rooms; generally a drawing-room fitting, a standard lamp, or a hall lamp. In every case these, when purchased, are bought either from manufacturers' lists or showrooms, and I must refer you to these makers for amount of profit.

Do you know for how many years the customer is bound by agreement to keep and use the installation? Do you know how much is charged for removing this installation if the customer does not further require it? Do you know how much profit the Free Wiring Company, whoever they may be, make out of begging the customer's gas fittings and selling them for scrap brass?

One of your correspondents the other day was talking about twin lead-covered wire. He incidentally sneered at the system of the famous B.I.W. Co. He talked about solder bases, and advised twin lead-covered rubber because solder bases were not needed. This digression may be obscure to you, but allow me in all gravity to inform you that your paper, Sirs, is very humorous. Some day I will write you a short clear little paper on "free" wiring, and I'll give you all its secrets, and show you all its failures, and give you new information to supersede the old, and explain little things that are not yet clear, and smooth your dear rugged old cheeks, and teach you to believe that no matter who does the work, the work being done tends to electrical progress.

Free Wirer.

March 31st, 1900.

Gas v. Steam-Driven Central Stations.

My attention has been called to an article in your paper referring to a report of mine relating to King's Lynn, on which you comment. If those who have read your article wish to know the real facts, I advise their perusing the report itself, which was published *in extenso* in the *Lynn Advertiser* of March 16th, and in the *Electrical Engineer* of March 23rd. This will enable them to be in a position to judge whether I was not justified in employing strong expressions, and it will also afford them an opportunity of appreciating the impartial spirit in which your article was written.

Henry Robinson.

[Readers of the Electrical Review will readily appreciate that it was quite unnecessary, as well as impossible, for us to spare four or five columns for the publication of the reports of the two engineers which we had before us, therefore we endeavoured to deal impartially with the matter in our brief article. The writer of the above letter does not attempt to prove wherein we displayed other than an impartial spirit. Until he does so, there is no occasion for further comment on our part.—Eds. Elec. Rev.]

Running Lamps In Series.

I have an electrical plant running at 230 volts.

Will you kindly inform me through your journal what amount of current I should save by running 75-volt lamps, three in series? I have been informed it will effect a good saving.

Claremont.

York, *April 2nd*, 1900.

[While there can be no doubt but that low voltage lamps are, on the whole, more efficient and durable than those made for higher pressures, the difference is so variable that it is impossible to give a definite value for the economy due to the use of the former. There is, of course, no intrinsic advantage in the series as compared with the parallel connection—rather the reverse, for (1) if any one lamp fails, all three are extinguished; (2) all three lamps must be in use at once, they cannot be turned on singly. We expect our correspondent really meant to ask what electrical energy (not current) would be saved, and his informant probably intended him to understand a saving in leads might be effected, but the relative advantages are very evenly balanced, and we would rather be excused from deciding between them.—Eds. Elec. Rev.]

Chimney v. Mechanical Draught.

With reference to the question of chimney *versus* mechanical draught which is being discussed in your columns, may I point out that in Mr. Adams' article on the subject, which is quoted in your issue of March 30th, his conclusions as to the proportion of energy necessary to effect the draught is somewhat affected by there being no time element introduced in the calculation. It is quite true, of course, that under the conditions assumed in his article 5,625 foot-pounds of work would be done in carrying 25 lbs. of waste gases to the top of a chimney 150 feet high with the allowance he makes for friction, but when he reduces this to heat units per pound of coal burnt, the practical side of the question is somewhat lost sight of. Your correspondent, Mr. A. L. Steavenson, arrives at a result practically which seems to place mechanical draught at a disadvantage. Taking Mr. Steavenson's figure for water evaporation, and applying Mr. Adams' argument, the disadvantage appears to be more marked.

Mr. Steavenson's boiler burns 15½ lbs. coal per minute, which should produce nearly 390 lbs. of waste gases per minute requiring energy to the extent of 15·5 × 5,625 or 87,237 foot-pounds per minute.

Assuming Mr. Adams' figure 0·028 for the efficiency of the boiler engine and fan combination, there would be required

$$\frac{87{,}237}{0{\cdot}028 \times 33{,}000} = 94{\cdot}8 \text{ H.P.}$$

to produce mechanical draught for one of Mr. Steavenson's boilers.

This result of combining Mr. Steavenson's and Mr. Adams' figures is interesting.

A.M.I.C.E.

Our Patent Laws.

Your leaderette of 23rd ult. supplies me with an excuse for offering a suggestion as to the examination for novelty.

In America the grant of a patent may be refused on the ground that (1) the invention has been anticipated, and (2) that the apparatus for which a patent is required is not practicable. In regard to (1), anticipation is often a matter of opinion, and an application refused by one examiner might have been allowed had it gone before another. The patent cases which are tried from time to time in the American courts show us that the examination does not guarantee against infringement. As regards (2), the question of practicability is one with which the examiners are hardly competent to deal, and which occasionally leads to injustice, as when the grant of a patent was refused to one of the early inventors of alternating current transformers on the ground that the apparatus was not practicable.

In regard to examination for novelty, the procedure I should suggest would be as follows:—The application for provisional with £1 stamp would be made as at present. When notifying the inventor of the acceptance of his provisional specification, the Patent Office would supply him with the numbers of any previous patents which (so far as the examiner could tell from the general description in the provisional) relate to a similar invention. The inventor would then examine these patents, and if he found that they were anticipations he would abandon his application either wholly or in such parts as were anticipated. If he decided to proceed he would file his final specification as at present, but instead of the present fee of £3, he would pay a first fee of £1. With the definite description now before him, the examiner would make a second search, and if there were clearly no anticipations the inventor would be notified, he would then pay the second fee of £2, and the final specification would be accepted and the patent sealed as at present.

If, however, the examiner found previous patents which in his opinion anticipated the invention, the numbers and particulars would be supplied to the inventor. If the inventor considered that he had been anticipated, he would abandon his application at this point, but if he decided that this was not the case, he would notify the Patent Office of his desire to proceed, would pay the £2 second fee, and the patent would be completed in the usual way. This method of procedure would save the inventor from wasting time and money on things already patented, while at the same time he would not be liable to unjust refusal of a patent. The question of practicability is one with which I do not consider the Patent Office should concern itself.

Claude W. Hill, M.I.E.E.

*** Pressure upon our space compels us to leave over until next week two letters on "Wiremen's Woes."—Eds. Elec. Rev.

Effect of Electric Light and Incandescent Gas Light on the Eyesight.—The following conclusions have been arrived at in the "Augenkhink" of the University of Heidelberg with reference to the effect upon the eyesight of the electric incandescent and the gas incandescent light:—

Neither the electric light nor the incandescent gas light have any bad effect upon the eyes. In the case of electric incandescent lamps any such effect is entirely out of the question.

Incandescent gas appears to more nearly approach the character of daylight than does the electric light, on the principle that that artificial light which has a spectrum most nearly resembling that of sunlight is the best, it would appear from this point of view the incandescent gas may be given the preference as far as our eyes are concerned.

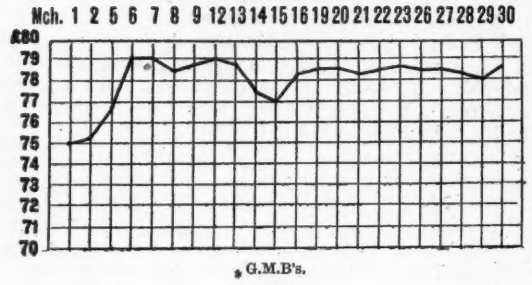
The heat given out by the newer forms of incandescent gas is said to be only half that of the electric light. On the other hand, there is no vitiation of the atmosphere where the electric light is used.

For the lighting of rooms, especially such rooms as concert and lecture halls, where many people remain for long periods at a time, the electric light is, without doubt, to be preferred to all others from a hygienic point of view.

F

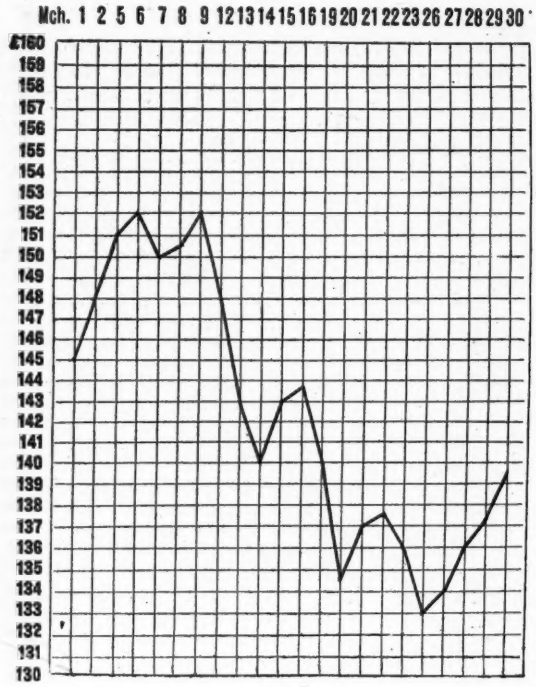
METAL MARKET.—Fluctuations in March.

COPPER.*

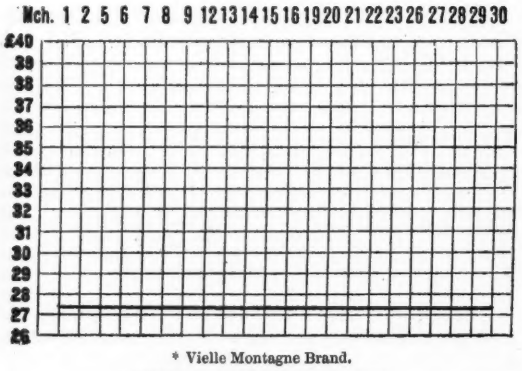


* G.M.B's.

TIN.

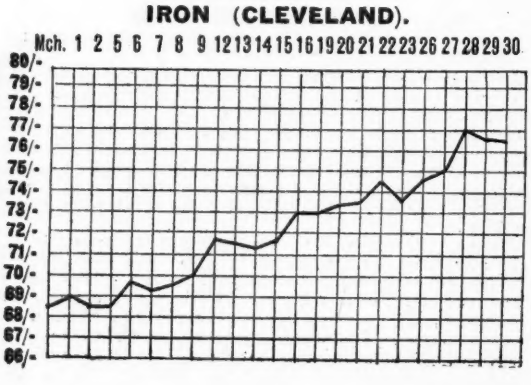


ZINC.*



* Vielle Montagne Brand.

IRON (CLEVELAND).



BILLS BEFORE PARLIAMENTARY COMMITTEES.

Hamilton, Motherwell and Wishaw Tramways.

This Bill, promoted by the British Thomson-Houston Company, came for the first time before Mr. Jeffreys' House of Commons Committee on Wednesday last week, the opponents being the North British Railway Company and the Caledonian Railway Company.

Mr. Balfour Browne, Q.C., in opening, said the Bill proposed to incorporate and confer powers upon the Hamilton, Motherwell and Wishaw Tramway Company to supply a number of growing places in Mid-Lanark with a very efficient system of tramway communication. The promoters of the Bill had been engaged in similar undertakings, and there was no doubt as to their financial ability to carry out the scheme. All the localities affected wished to have the tramways. The street mileage for the trunk line was 8½ miles, and for the proposed branch line 3¾ miles, and there would be altogether 21 miles of single track. The tramways would be worked by the overhead system of electric traction, and there would be a generating station at Motherwell and one at Larkhall. Last year a similar scheme was placed before the Light Railway Commissioners, who, however, thought it was one which ought to come before Parliament. The local authorities were to have the option of purchase at the end of 25 years as a going concern, and at the end of 35 years and every succeeding seven years for the value of the tramways as they stood. Further, it was provided in the Bill that one local authority would be free to act without the others, and purchase the part of the tramway which was within its jurisdiction. There was also a provision to the effect that after a dividend of 4 per cent. had been paid on the capital of the company, the local authorities were to receive a share of any additional profit accruing from the tramway. In the event of the local authority or the company constructing a tramway which would form a combination of the branch with the lines now proposed, the local authority for the company would be mutually entitled to exercise running powers over the respective undertakings on such terms and conditions as might be fixed by arbitration.

A very large number of witnesses were called in support of the Bill.

Mr. James Stuart, of the firm of Messrs. Warren & Stuart, engineers to the promoters, said the total estimated cost of the permanent way, paving, and other incidental work was £150,514, and the line would be worked by overhead electric traction. The total cost of the scheme would be £325,000.

Mr. Philip Dawson, who said he had been connected with nearly all the electric tramways in the United Kingdom, said there would not be the slightest difficulty in carrying out the scheme. The electrical equipment was estimated to cost between £100,000 and £125,000.

The Committee decided to pass the preamble of the Bill with the exception of tramway No. 2 running to Larkhall. The clauses were then adjusted and the Bill reported to the House.

Hastings Tramways.

On Monday, Tuesday, Wednesday, and Thursday last week, the Select Committee of the House of Commons, presided over by Mr. Hobson, considered Mr. Murphy's Bill to provide Hastings with tramways electrically worked.

Mr. Pembroke Stephens, Q.C., who opened the case for the promoter, went into the previous efforts which had been unsuccessfully made to get tramways for Hastings, and really the only question now in Hastings was whether the tramways should be provided by public or private money. The scheme brought forward by the Corporation last Session, did not pass the House of Lords Committee, and consequently the Corporation now supported the proposals of Mr. Murphy, and it was proposed that the line should be constructed by the Hastings Electric Tramway Company, which was largely developed by Mr. Murphy, who was connected with tramways in South-East London, Dublin, and Cork, and was now constructing a line to connect Margate, Ramsgate, and Broadstairs. Mr. Murphy had also received sanction under the Light Railways Act to a line between Bexhill and St. Leonards. Mr. Murphy's company had entered into an agreement with the Corporation, under which it was arranged that the company should pay the Corporation so much per mile as wayleave. The company had also agreed to construct tramways on the sea front to connect with the west end of the St. Leonards and Bexhill Light Railway should the Corporation consider at any time that this was desirable.

A great deal of evidence was called in favour of the scheme.

Mr. W. Cooper, M.I.C.E., in opposition to the scheme, said he considered that Hastings was not generally suitable for tramways, and he found little difference between the present scheme and the one rejected last year.

The Committee decided to pass the preamble of the Bill, and proceeded to adjust the clauses.

Airdrie and Coatbridge Tramways.

This Bill, promoted by the New General Traction Company, came before Mr. Jeffreys' House of Commons Committee on Tuesday and Wednesday last week.

Mr. Fitzgerald, Q.C., for the promoters, explained that it was originally a Bill for the construction of a tramway system to be worked by electricity throughout the two towns of Airdrie and Coatbridge, but in consequence of the local authority of Coatbridge not giving its sanction, that part of the Bill relating to Coatbridge had to be struck out. What was now before the Committee was a scheme

for the construction of 2½ miles of tramway in the town of Airdrie. Public opinion in Airdrie was unanimously in favour of the scheme. The New General Traction Company had a large capital, and had already constructed and was the owner of considerable tramway systems in other parts of the United Kingdom. It owned the tramways at Coventry and Douglas in the Isle of Man, and had in the past few years constructed a system of tramways at Norwich. The only opposition came from the Caledonian Railway and the North British Railway Companies, who had combined to oppose the scheme on the ground of competition. Evidence was given in support of the Bill by Ex-Provost James Connor, of Airdrie, and Provost Martin, the latter stating that the promoters of the scheme was the New General Traction Company, who were acting at the request of the Airdrie Corporation.

Mr. Winslow, the engineer to the scheme, said that it was proposed to work the tramways on the overhead system.

Mr. Pope having addressed the Committee in opposition to the Bill on behalf of the Bill, the Chairman announced that the Committee had decided to pass the preamble on condition that the capital was cut down to £45,000.

LEGAL.

Goldberg *v.* Liverpool Corporation.

In the Court of Appeal on Tuesday, before the Master of the Rolls, Sir Francis Jeune, and Lord Justice Rigby, the case of J. Goldberg and Sons, Limited, *v.* the Mayor, Aldermen and citizens of Liverpool was heard on appeal by the defendants from an order of the Vice-Chancellor of the County Palatine Court of Lancaster.

Mr. Neville, Q.C., with whom was Mr. Macmorran, Q.C., Mr. Maberley, and Mr. Rutherford, in opening the case, said the appeal was by the defendants from a decision of the Vice-Chancellor with regard to the right of the Corporation to put a post for electrical wires covered with a fuse box in a position which the plaintiff said was inconvenient to him. The plaintiffs were Goldberg & Sons, Limited, who had a wholesale shop in Paradise Street, Liverpool, and the defendants were the Corporation of Liverpool, who owned and worked the tramways in the city. They had done so for a great many years, but recently they had undertaken the introduction of electric trams in place of horse-drawn trams, which had been used hitherto. Under the Liverpool Corporation Tramways Act of 1897 the Corporation had power to adapt the tramways and streets for the purposes of mechanical traction. There was also a provisional order which incorporated portions of the Act of 1897.

The Master of the Rolls: Is there anything in the provisional order which cuts down the operative clauses of the Act of 1897?

Mr. Mattinson, Q.C., (with whom was Mr. Rotch) for the defendants, said there would be an argument as to that.

Lord Justice Rigby: Were there tramlines in Paradise Street before?

Mr. Neville said there were not, but a line along the street was found a necessary deviation for the purpose of working the electric system with safety and convenience.

Lord Justice Rigby: Then does the Act apply? There does not seem to have been any tramways there to adopt?

Mr. Neville: In the interpretation clause of the Act of 1897 the expression "the tramways" includes the tramway lines existing and any other tramway lines which may hereafter be constructed and worked by the Corporation.

Counsel proceeding, said the wires carrying the currents might either be supported by centre poles of T shape, or by span wires carried by side posts planted in the pavement, or by means of rosettes affixed to the buildings on either side of the street. Rosettes could only be fixed by consent of the owners of the buildings, and in consideration a nominal rent of 5s. was paid. The span-wire system was decided upon by the Tramways Committee for Paradise Street, and a circular was issued to the owners of property in the street asking for their permission to affix rosettes to the buildings. Shortly before that holes had been sunk along the edge of the curb, to see whether, if it was necessary, posts could be placed there, but it was found impracticable, on account of gas mains and electric wires, which lay some little distance below the surface. Owing to the great strain upon the posts, it was necessary to sink the posts to a depth of 6 feet.

Lord Justice Rigby: The posts are only wanted in default of permission to fix rosettes.

Mr. Neville said that was so. In this particular case the engineers decided that where poles had to be placed in Paradise Street, they must be put as near the building line as possible. In reply to the circular, he had mentioned Messrs. Goldberg would not give their consent to a rosette, and a post therefore became necessary at that point to put a post. A hole was first sunk on the right hand side of the street close to the plaintiffs' buildings. Then somebody came out of the shop and said if the post was placed there it would injure the building. Thereupon the contractor consulted the engineer, and another spot nearer College Lane was decided upon, but again somebody came out of the plaintiffs' premises and complained that the post was right in front of their entrance, and asked to have it "shifted back a little." It was shifted accordingly to its present position.

Lord Justice Rigby: Is Goldberg's a retail business?

Mr. Neville said it was not. It was entirely a wholesale business for the supply of tobacconists' sundries. After the pole was finally in position, Messrs. Goldberg's solicitors wrote to the defendants: "Our clients feel that the pole has been placed in its present position with the view of causing the greatest possible inconvenience and trouble to their customers as well as to themselves in consequence or their not consenting to have a rosette affixed to their buildings, and unless something is done by the Corporation to remedy the present position of matters, our clients will have no alternative but to take such steps as they may be advised. If the pole is necessary, could it not have been placed where the lamp-post is at the present time?" With reference to the last point that had been tried and found impossible, as the lamp-post was on the curb, beneath which there were gas and other mains. In reply to the above letter, the defendants pointed out that the reason why the post was put in the place in question was, that permission not having been given to fix a rosette to the buildings there was no other alternative. Messrs. Goldberg seemed to have got the idea into their heads that the erection of the pole at this particular point was a method adopted by the Corporation to punish them for their contumacy in not allowing a rosette to be fixed to their premises, but there was really no ground for any such idea. The post could not be placed in any other position, and there was no alternative. There was a good deal of further correspondence between the parties, and in the result the plaintiffs brought an action in the Vice-Chancellor's Court. Now, this case was one of very considerable importance to the Corporation as, if they were compelled to remove this post, they would have any number of actions brought against them by people who might consider themselves inconvenienced by having these poles erected in front of their premises. If the Vice-Chancellor was right in thinking that the proper way to deal with the case was to consider expert evidence on the one side and on the other, and finally to decide which, in his opinion, was the best possible position for the pole, then it opened up a vista of interminable litigation. The Corporation had in these matters to consider the interests of all parties, and they did everything possible to consult the convenience of the frontagers, with due regard to the convenience of the public and the proper working of the tramway system. In the present instance they had tried to do everything possible to avoid causing the plaintiffs inconvenience, and it was after mature and deliberate consideration that they came to the conclusion that there was no other position in which the pole could be placed. The real question, he submitted, in this case, Could any Court interfere with a discretion possessed by the Corporation and exercised in a *bonâ fide* way? There was in this case no evidence of bad faith or perversity, except the evidence of people who suggested that it was practicable to put the pole in another place, where it would less interfere with the convenience of the plaintiffs.

The Master of the Rolls: I should think you might leave the question of bad faith to the other side.

Learned Counsel having read the judgment of the Vice-Chancellor,

The Master of the Rolls said a difficulty seemed to arise on the last words of the judgment. The learned judge seemed to have come to the conclusion that what the defendants had done was perverse and vexatious.

Mr. Neville: How?

The Master of the Rolls: Because you don't seem to have taken the trouble to ascertain whether there was not a more convenient place for this post.

Mr. Neville: I say we took a great deal of trouble.

Lord Justice Rigby: All that was necessary, surely, was to make a few holes?

Mr. Neville: We made holes and discovered where the mains lay.

Sir Francis Jeune: When the Corporation made up their minds to accept the advice of the engineers, had they made any investigation as to the real facts?

Mr. Neville thought they had taken a great deal of trouble.

Sir Francis Jeune: Why couldn't they have taken College Lane?

Mr. Neville said the defendants knew there was a gas main running along College Lane, which only had a pavement 5 feet wide. If the post had been placed there pedestrian traffic would be blocked, and that the Corporation were not inclined to do. They had to consider not only the rights of Goldbergs, but the rights of the public. The question of the method in which the engineers who advised the Corporation arrived at the conclusions which induced them to give the advice they did was not a proper subject matter for inquiry before the Court at all.

Lord Justice Rigby: Unless it can be shown definitely that they were wrong in their methods.

Mr. Neville: Yes, if they acted with what he might call sinister motives.

The Master of the Rolls: But apart from that, are they not bound to exercise their powers in a reasonable manner? If they could have found another position for this post equally convenient to them, could the point have been withheld from a jury?

Mr. Neville said he should submit so. There were a variety of cases upon the point. Where it was a question of the exercise of a discretion committed to the undertakers by Act of Parliament, and that discretion had been exercised honestly, there was no appeal.

The Master of the Rolls: They are, I suppose, bound to consider everybody in a reasonable way, and if that was done he did not think the Courts would interfere. He quite saw if they went too far they might be turning the Court into a tribunal to decide where these posts were to be put.

Mr. Neville said that was what it seemed to him to come to. Look what would happen if they once embarked upon the inquiry which was pursued by the learned Vice-Chancellor in the present case. Possibly, in a great number of cases, if they called evidence on the one side, and on the other, they might find places where posts might be put with less inconvenience to a certain number of people, than the sites selected by the Corporation, but they were not entitled to

enter upon such an inquiry in the absence of evidence showing that the Corporation had acted in bad faith without exercising their discretion.

Mr. Macmorran having briefly followed on the same side,

Mr. Mattinson for the respondents (the plaintiffs) said that the complaint in the present case did not rest upon the mere fact that the pole was placed on the pavement. The plaintiffs' case rested on the fact that the defendants had placed a pole with a fuse box in combination, immediately in front of their main business entrance, so near and under such circumstances as constituted, in the opinion of the learned judge who tried the case, a nuisance. If the decision of the Vice-Chancellor was affirmed, there was not the slightest reason to think that the Corporation of Liverpool would be persecuted by other persons who would say that the poles were put in such a position as infringed their rights. A fundamental part of the present case which he (counsel) thought would distinguish the case from a large mass of the authorities on which his learned friend, Mr. Neville, relied, was that in the present case it was established that the defendants had themselves created the nuisance. That was the first point, and in the next place it was found that from that nuisance created by the defendants, the plaintiffs had sustained special and particular damage. The learned counsel asked if the Corporation had any power to do what they did at all. Was there any statute which *primâ facie* justified them in doing what they did? The statute relied upon by the defendants was the provisional order of 1898. At that time there were no tramways in Paradise Street. Although he should not dispute for a moment that the Corporation had full power under various statutes and provisional orders to use the carriageway for the purpose of constructing their tramway, he should contend that they had no power to use the pavement.

The learned counsel had not concluded his address when the Court arose.

The hearing was resumed on Wednesday, when Mr. Mattinson, Q.C., continued his arguments on behalf of the respondents in support of the finding of the Vice-Chancellor. When the Court rose on Tuesday he was discussing whether the Corporation had any statutory authority at all to put the poles on the pavement. His contention was that the word "street" used in the Act of 1897 comprised the carriageway only. Of course, if the word "street" used in the section comprised the pavement as well as the carriageway, his argument on this point would not be well founded. Even assuming the defendant Corporation had power to put the poles and fuse boxes on the pavement, he should submit that Section 36 of the Act only authorised them to erect in any street such poles and fuse boxes as were, in fact, necessary for the efficient working of the tramway system, the necessity of particular poles and fuse boxes being a question for the Court or experts to determine. In this assumption he (counsel) must concede that if a nuisance to the plaintiffs was a necessary incident to the defendants making an efficient tramway, then the plaintiffs must submit.

The Master of the Rolls: There is no compensation clause, is there?

Mr. Mattinson replied that there was not. The question he should discuss a little later would be as to whether it was made out by the Corporation that it was a necessary incident to the efficient system of tramway working in Paradise Street that the pole and fuse box should be placed in the very position in which it was placed. The Act of Parliament did not authorise the Corporation to erect the pole and box in front of the plaintiffs' premises. It was not a case in which the Corporation was authorised to take a particular piece of land. The Corporation were not in terms authorised to put the pole and fuse box in front of the plaintiffs' door, or in front of the door of other persons. It might be, however, that they were authorised to do it, if they could not otherwise complete their system. That was, however, subject to two qualifications, one being that the Corporation should act *bonâ fide*, and not from any indirect motive, and the other qualification was that the Corporation should act without negligence, and in this connection "negligence" had been defined by Lord Blackburn as the "failure to do everything reasonable to prevent damage to the person complaining." He hoped to satisfy their Lordships when he came to the evidence that it was perfectly clear that the Corporation might have completed their tramway system in this street by putting the fuse box and the pole in at least three areas other than the particular point where, in fact, they placed them. The learned Vice-Chancellor, who had the witnesses before him, had found not only that the pole and fuse box constituted a nuisance, but he had also found a series of facts, the effect of which was that he found that it was not necessary for the defendants in the course of efficiently constructing their tramways to put the pole and box in the particular spot they had chosen. If the pole and box were moved 6 feet further up College Lane, or about 10 feet in the direction of Paradise Street, the plaintiffs' cause of complaint would have been removed, because the substantial interference with the access to their premises would have gone. The evidence was that a support had to be provided at every 120 feet, but the next support coming from Lord Street was distant only 95 feet, so that they could have gone on 25 feet further. The next support was 110 feet distant, and the one again after that 113 feet, but for some reason Mr. Brodie, the engineer, thought fit in this particular instance to stop short at 95 feet.

The Master of the Rolls: Do they not say that this is the lowest point of a dip?

Mr. Mattinson said that was a very trifling point. There was a gradient, but it was so slight that it was not perceptible to the eye. The learned counsel then referred their Lordships to the authorities bearing on the matter; and having read evidence given in the Court below, contended that the learned judge had arrived at a correct conclusion, and that the appeal ought to be dismissed.

Mr. Neville, in reply, referred to the suggestion that Mr. Brodie, the engineer, had acted with bad faith in the matter, and that all the transactions complained of followed upon the refusal of Messrs. Goldberg to have a rosette fixed upon their premises. Looking at the facts, he was, he thought, justified in saying that a more unfounded suggestion was never made in a court of justice. With regard to the points raised by his learned friend, if the defendants had got to show that in no other way could they work their tramways except by planting this pole and fuse box in this particular spot, it was perfectly obvious they could have no case at all. He had no doubt there were dozens and dozens of places in which the pole could have been put, and yet the tramways worked with efficiency. They were therefore really beating the wind in arguing this question about the pole being placed in this spot or in that spot, supposing the plaintiffs were right. If they put the pole in front of a man's house, he could come to them and say that next door would suit their purposes just as well, and that they must put it there. Then the next door man would come and say that they must not put it there, but they could put it opposite Goldberg's. So things would go on, and every man would be able to turn them off the spot selected. He submitted his learned friend's proposition was entirely wrong in law. It was not a question of whether they could find another place for this pole, but it was a question whether, in the opinion of the Corporation, this was an expedient place to put it. The judge of that was not the Vice-Chancellor or the experts who were called, but the Corporation themselves, and having exercised their discretion then the Court would not interfere with them in any way.

The Master of the Rolls, in giving judgment, said he did not think anything could be gained by reversing judgment in this case. The opinion of all of them was that the view taken by the Vice-Chancellor was not the correct view in point of law. The first thing was to ascertain what powers the defendants had, and the second, whether those powers had been *bonâ fide* exercised for the purposes for which Parliament had conferred them, and that involved the question which had been very much pressed upon them, as to whether the Corporation, through their officers, had acted *bonâ fide* in the matter, or had acted with the ulterior view of more or less paying off the plaintiffs because of their refusal to assent to the affixing of a rosette outside their house. As to the first point, he did not think there was any real difficulty, nor did the Vice-Chancellor think so. The power to make the tramway along Paradise Street was conferred by an order in Council of 1898, which was made under the authority of the Act of 1897, and there could be no doubt of the defendants' power to make an electric tramway along the same street. He could not assent to the argument of Mr. Mattinson, that the words "any street" in the Act did not apply to College Lane, or did not apply to the pavement as distinct from the carriageway. There could be no doubt that the powers conferred by Section 36 were applicable to any street, including College Lane, and that the pavement was part of the street for the purposes of constructing, erecting, laying down, and maintaining in, over, or under its surface such works as might be necessary or expedient for the purpose of adapting the tramway to the use of mechanical power. As to the second point, whether the defendants had acted *bonâ fide* in the exercise of their powers, it was obvious that what they had done was for the purpose, and *bonâ fide* for the purpose, of adapting this tramway to the use of electrical traction. A pole was genuinely wanted for the purpose, and a fuse box was genuinely wanted, but it was said that the officers of the defendants had not acted *bonâ fide*. That the Corporation of Liverpool, who themselves had this matter under consideration, and came to the conclusion that they could not conveniently or properly, or would not move this pole—that they had acted *mala fide*, or in a spirit of hostility to the plaintiffs, was not now suggested, but it was said that Mr. Brodie, the electrical engineer, had been actuated by motives of hostility to Mr. Goldberg, and that he had not *bonâ fide* exercised the powers of the Corporation for the purposes of the undertaking. Well, when one came to look at that, he thought Mr. Neville had succeeded in showing that that view could not be sustained. In order to succeed in his contention, the plaintiffs must make out the essential propositions that there had been an abuse of the power of the Corporation. The Vice-Chancellor had gone into the question of whether a more convenient spot could not have been found for this pole, but to his mind that was an inquiry which they ought not to go into. If they did the result would be that the Court would have to themselves erect these poles in all parts of the city of Liverpool. That was not their duty or province, but their duty was to control the Corporation with the exercise of their powers if it could be shown that the Corporation were exercising them in a way which called for interference. In this case they considered that the powers of the Corporation had been *bonâ fide* exercised for the purposes of the tramway undertaking, and the Court would not interfere. The appeal would accordingly be allowed, and the action dismissed with costs there and below.

Sir Francis Jeune and Lord Justice Rigby concurred.

Glasgow International Exhibition, 1901. — It is officially notified that all applications for space at the Glasgow International Exhibition, which is to be opened in May, 1901, must be lodged not later than June 1st with the general manager, Mr. H. A. Hedley. There are in all eight classes, embracing agriculture, mining, industrial design and manufactures, machinery and labour-saving appliances in motion, locomotion and transport, marine engineering and shipbuilding, lighting and heating, science, education, music, sports and sporting appliances.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending April 4th, 1899.		Week ending April 3rd, 1900.	
Alexandria	Value £64	Adelaide	Value £30
Amsterdam	90	Alexandria	92
Bangkok	29	Amsterdam	800
Buenos Ayres	35	Bombay	37
" Teleg. mat.	190	Buenos Ayres. Teleg. mat.	178
Calcutta	11	Calcutta	430
Cape Town	44	Cape Town. Teleg. mat.	3,693
Chinde	18	Colombo	91
Colombo	284	Copenhagen	61
Delagoa Bay	5	" Teleg. mat.	115
Demerara	24	Demerara. Teleg. cable	261
Durban	21	Durban	548
" Teleg. mat.	28	" Teleg. mat.	584
Genoa	285	Gothenburg. Teleg. mat.	77
Hong Kong	1,020	Hamburg. Teleg. mat.	810
Labuan Teleg. mat.	42	Hiogo	190
Launceston	186	Kobe	146
Madras	10	Lyttelton	251
Melbourne	170	Malta	21
Monte Video	70	Melbourne	321
Otago	7	Monte Video	633
Reval	24	Penang. Teleg. apparatus	310
Rio de Janeiro	79	Port Elizabeth. Teleg. mat.	281
Rosario	9	Port Said	24
St. Petersburg	55	Reval	89
" Teleg. mat.	125	Rotterdam. Teleg. mat.	400
Sydney	102	St. Petersburg. Teleg. mat.	250
Valparaiso	100	Seville	270
Wellington	234	Shanghai	195
Yokohama	96	Singapore	61
		Sydney	1,080
		Trinidad	31
		Wellington	128
		" Teleg. mat.	470
		Yokohama	350
Total	£3,452	Total	£12,808

Foreign Goods Transhipped.

Durban. Elec. mat.	£20	St. Petersburg. 14 tons teleg. wire	—
New York. Elec. machinery	105		
	£125		

American Rails.—It is stated that the Metropolitan Railway Company (London) has placed an order for 1,500 steel rails with the Maryland Steel Company, of America.

Bankruptcy Proceedings.—The public examination of F. B. de Foe Paynter, electrical engineer, Catford, will be held at Bankruptcy Buildings, Carey Street, to-day, April 6th, at 12 o'clock noon.

A receiving order has been made against Edwin Bates, electrician, late of Manchester, now of Stockton, upon his own petition.

Books Received.—"La Pratique Industrielle des Courants Alternatifs," by G. Chevrier. Paris: Georges Carré & C. Naud. 9 *fr.*

"Electric Bells," edited by P. N. Hasluck. London: Cassell and Co., Limited. 1s.

Cable Connector.—The British Electric Works Company, Limited, send us a sample of their 5-ampere "Stellite" cable connectors. On the illustrated price list which they have issued, it is claimed that it is mechanically and electrically a perfect connector. The article is a most simple and ingenious arrangement, and the connection is very easily made. The cable is inserted and the clip then closed with a hammer. It may then be soldered if required. The joint is instantaneous.

Catalogues and Lists.—Messrs. Green & Boulding, of Bunhill Row, E.C., have sent us an illustrated pamphlet relating to the Buffalo automatic injector.

The following illustrated pamphlets have come to hand from the B.T.H. Co.: No. 58, punched clip switches; No. 59, magnetic blow-out automatic circuit breakers; No. 60, quick-break switches.

The British Westinghouse Company's publishing department send us a copy of circular No. 1,023, entitled "D. C. Lighting and Power Switchboards, Type 5."

Electricity for Newspaper Printing.—In our notice of the Holmes-Clatworthy system of electric driving of printing machinery, we stated that all the newspapers there named are worked on this system. Such is, however, not the case, as although all of the motors were supplied by Messrs. Holmes, some of them were installed before the Holmes-Clatworthy system was invented. Of the newspapers mentioned, the following are fitted, or are being fitted, with the Holmes-Clatworthy system:—*Liverpool Courier*, 4 sets; *Globe*, 1 set; *North British Daily Mail* and *Glasgow Weekly Mail*, 2 sets; *Daily Graphic*, 2 sets; *People*, 8 sets; *Manchester Guardian*, 2 sets; Alpine Publishing Company, Limited, 2 sets.

Fire Tests.—An important series of tests was undertaken on Wednesday last week by the British Fire Prevention Committee at its testing station near Regent's Park. Sir John Taylor, K.C.B. (H.M. Office of Works), and Mr. Arthur Cates (Crown surveyor), represented the council, and Mr. Edwin O. Sachs, the executive. There was an unusually large attendance of members and visitors, including the leading district surveyors and representatives of the local authorities. One of the tests was with a floor of wood joists, with concrete filling, and a plaster ceiling on expanded metal lathing, the concrete, however, protected joists from below. This floor was subjected to a test of a gradually increasing fire reaching to a temperature of 2,000° F. for a period of two hours, followed by the application of water. Two doors were also tested, one of three-thickness deal, 2¼ inches thick, and the other of teak with a skeleton of 2 inches solid material, but the panels in two thicknesses. This test was of about an hour's duration. Among the recent tests applied for, are two by the British Uralite Company (Uralite boards), and one by Messrs. G. W. Williams & Sons (fire blinds). The next testing day is Wednesday, April 11th.

For Sale.—From our small advertisements this week, particulars may be obtained of the freehold works of Accles, Limited, at Birmingham, which are offered for sale by tender by Messrs. Faller, Horsey, Sons & Cassell. The works are described "ammunition works, cartridge factory, cycle and general engineering works, and proof range." Tenders have to be in by Tuesday next, April 10th.

The Board of Works of St. Olave, Southwark, want offers for the purchase of a small dynamo. See "Official Notices" to-day.

Italy.—It is reported that Messrs. Brown, Boveri & Co., of Baden, Switzerland, are about to establish branch electrical engineering works in Milan.

Maxim Lamps.—We are informed that the Hiram S. Maxim Electrical Corporation, Limited, has now placed the "Maxim" electric glow lamp upon the market. The makers claim as a special feature its remarkable efficiency, the standard being not lower than 3 watts, and "this efficiency, which does not shorten the life of the lamp, is maintained throughout." The company's works are situate at 44, Gillingham Street, Victoria Station, S.W., and they are organised to cope with heavy demands. The company have on hand large stocks of lamps in ordinary candle-powers and voltages both high and low.

Municipal Trading.—At the annual meeting of the Association of Municipal Corporations held on Saturday at the Guildhall, Sir Albert Rollit, the president, in moving the adoption of the report, having referred to other subjects, said that the question of the moment was that of the so-called, but nevertheless miscalled, municipal trading, an absurd and misleading misnomer. If by municipal trading it was intended to refer to such undertakings as water, gas, electric lighting and power, tramways, markets, the housing of the labouring classes, and other great industries which had been entrusted by Parliament to corporations, the council would be prepared to meet such an emergency with the utmost confidence. They would be able to show that these undertakings had been carried on with efficiency and economy and for the general benefit of the community. Of trading in the ordinary and popular sense of that term on the part of our municipal corporations there was practically little or none. The Government had, however, been prevailed on to present to Parliament a resolution appointing a joint committee of both Houses "to consider and report as to the principles which should govern powers given by Bills and provisional orders to municipal and other local authorities for industrial enterprise within or without the area of their jurisdiction"; but the supporters of the crusade against corporations meant, in reality, not the principles, but the limitations which should be imposed on corporate action, or at least on the sphere of civic activity. What the association strenuously objected to was the general imposition of arbitrary and artificial restraints, especially at the hands of those who had little or no practical experience of municipal matters.

New Journal.—From Durban we have received the first number of a new monthly journal which has been brought out under the editorial care of Mr. Robert Dives. The title of the journal is *Industries*, and it is devoted to the interests of Colonial industries. A machinery and plant register is one of the leading features.

The Paris Exposition.—According to the latest official list issued by the Royal Commission for the Paris Exhibition, there are 620 British and Irish exhibitors.

Registration of Boilers.—In the House of Commons on 2nd inst., on the motion of Sir W. Walrond, the following members were appointed as a Select Committee on the Registration and Inspection of Boilers:—Sir W. Arrol, Mr. Crombie, Mr. Emmott, Mr. Fenwick, Sir J. Fortescue-Flannery, Mr. Galloway, Sir E. Gourley, Mr. Hazell, Mr. Heath, Sir A. Hickman, Sir W. Houldsworth, Mr. M'Ghee, Mr. Penn, Colonel Pilkington, and Mr. Renshaw.

Russia.—The Russian Electrotechnische-fabrik (Siemens and Halske) of St. Petersburg is increasing its capital from 4,000,000 to 7,000,000 roubles.

Trade Announcement.—Messrs. Rankine, Cockayne and Co., Limited, inform us that they have commenced business as engineers, brass founders, coppersmiths, &c., at Regent Brass Foundry, 10, Bantinck Street, Liverpool. They have equipped these works with new and modern machinery and tools. All work will be carried out under the personal supervision of Mr. Samuel Cockayne, who has had extensive experience in the production of castings of all kinds, coppersmith work, repairs to steamships, galley work, &c. Mr. Cockayne was 25 years with the late firm of Siddeley & Co., Liverpool, and for the past 7 years partner in the firm of Messrs. E. H. Williamson and Co., engineers, &c., of Liverpool. The firm sends us an illustrated circular of Rankine's patent feed water filters.

ELECTRIC LIGHT AND POWER NOTES.

Alloa.—At a special meeting of Burgh Commissioners last week, it was stated that the agreement with the British Electric

below, contended that the learned judge had arrived at a correct conclusion, and that the appeal ought to be dismissed.

and shipbuilding, lighting and heating, science, education, sports and sporting appliances.

Plant Company to supply the town with electric light was practically settled, and that the building operations in connection with the new works would be begun in a very short time.

Birmingham.—We understand that the profits of the Electricity Department are sufficient to pay the interest and sinking fund on the £500,000 borrowed for the purchase of the works, and to leave a few thousand pounds to the good. The Committee has received more applications for putting in the electric light than can be complied with, and is putting down two or three thousand more horse-power.

Bolton.—A somewhat unusual kind of accident occurred last week in the electricity works. A balancer armature burst, the fragments flying in all directions, and breaking the lofty glass roof. Fortunately, no one was hurt.

Bradford.—At the Sunbridge Road destructor works on Monday, the chairman and deputy-chairman of the Cleansing Committee started a new dynamo and horizontal engine which have been erected for electric lighting at these works. The waste heat from the destructor is used for steam raising. The high-speed single-acting engine in connection with the electric lighting installation has been put down by Messrs. Thwaites Bros., the dynamo, designed to give an output of 85 amperes at 115 volts, has been constructed by Messrs. Roslyn & Appleby, and the wiring, arc lamps, &c., have been erected by Messrs. Rhodes and Webster.

At a meeting of the Electricity Committee last Friday a resolution was passed recommending that an application be made to the Local Government Board for authority to borrow a further sum of £56,000 for purposes of electric lighting.

Doncaster.—The Corporation electricity works were officially inaugurated on Monday last, when the Mayor started the engines and the Mayoress switched on the lamps; the ceremony was followed by luncheon at the Mansion House, at which the appropriate toasts were honoured. The works have been erected at a cost of £30,000, to the plans and specifications of Mr. J. N. Shoolbred, under the supervision of Mr. C. A. L. Prusmann, who remains as resident electrical engineer. The direct current three-wire system at 230 volts is employed; the boilers were supplied by Messrs. Tetlow Bros., Oldham; Messrs. Mather & Platt were the contractors for the generating plant, Messrs. Callender's Cable and Construction Company for the mains, Messrs. the E.P.S. Company for the batteries, and Messrs. Jas. White & Son for the switchboard. The charges for supply are 5d. per unit for lighting, and 3d. per unit for power.

Dublin.—When the Local Government Board inquiry regarding the electricity scheme was resumed on Tuesday last week by Mr. Cowan, the inspector, Messrs. S. Bushe, Q.C., M. C. Macinerney, Q.C. and P. O'C. White appeared for the Corporation; Messrs. T. M. Healy, Q.C., M.P., and J. M. Day for the ratepayers opposing the application; and Mr. D. O'C. Miley for the Dublin Electric Light Syndicate.

Mr. Robert Hammond, C.E., in reply to Mr. Bushe, said that in the earlier days of electric lighting Fleet Street would be looked upon as a very good site, but the demand for light had so increased that the Fleet Street site was entirely occupied now, and some alternative site must be found. Any difficulty of distance between the centre of generation and the area of distribution had of late been got over by a new system of energising. An economical generation was now more important than an economical distribution. The Pigeon House site was about three miles from Fleet Street. In the Deptford scheme the generating station was five miles from the distribution area. There was a Pigeon House scheme for Brighton three miles from the supply. At the Pigeon House there was cheap and easy access to sea-borne coal; the sea water was not going to be used in the boilers—for that they would use Vartry water, but they would use the sea water for turning the steam back into water, and so causing a vacuum which considerably assisted the engines. At the Pigeon House there was ample space for extension, and it was also away from any annoyance to anyone by smoke or vibration. Witness entered into the details of the scheme, which he designed for 100,000 lamps of 8-C.P. He would transmit the electricity at 5,000 volts to Fleet Street. From Fleet Street it would be transmitted to 19 sub-stations as a three-phase current of 5,000 volts, where it arrived with high pressure, and be there transformed to a proper pressure for the working of incandescent lamps. The witness began to read from a circular issued by Mr. Wright, the Brighton engineer, in which he said Mr. Wright promised his friends that if he were allowed to go from the Fleet Street of Brighton to the Pigeon House of Brighton.——

The Inspector asked was Mr. Wright present?

Mr. Wright answered that he was.

Mr. Hammond said Mr. Wright's cost of delivery was 1·68d., and he said he could immensely economise by being allowed to have a generating station in the suburbs. Witness believed they could deliver the electricity in Dublin at 1½d. Under his scheme the total earnings would be £38,500, which would leave gross profits as against interest and sinking fund of £21,969, and the scheme was so devised that by a little extension they would largely increase their profit, bringing it up to £34,800. Witness detailed the various items which went up to make the £254,000, the amount of the loan now asked for. With regard to the supply to the present restricted area he proposed to convert a certain quantity of the current at Fleet Street from three-phase to single-phase, and distribute it over the present high tension feeders. There would be no difficulty in working the old district in that manner as part of the new scheme, and thus preserve all the present carefully spent money.

Witness, in answer to further questions, spoke of a number of English and Scotch towns where the continuous system was adopted. There were, he said, important places on the Continent where they did not trouble to translate the alternating into continuous for distribution, and they did what he proposed to do in Dublin. Nowhere in Great Britain and Ireland was there anything like the proposed Dublin installation. The high pressure alternating was, however, adopted in many American cities. The city engineer did not profess to give an opinion on the Pigeon House Fort scheme. He thought the city engineer would say that he left it entirely to witness. Mr. Ruddle seemed very happy over witness's report as to the Pigeon House. Witness was the original contractor for the Fleet Street station, and lost about £2,000 over it. Of the three mains from the Pigeon House to Fleet Street, one would be a stand-by main and the other two would deliver between 2,600 KW. daily, equal to 86,666 lamps of 8 C.P. There might be a 10 per cent. loss. He added the money already spent in Fleet Street (£80,000) to the £254,000 now proposed to be borrowed, and had shown that on the total amount there would be a profit.

Re-examined by Mr. Bushe—In all places where the continuous supply was established they were either old towns or small districts which could be worked by low pressure. There was a controversy as to whether continuous current arcs or alternating arcs were better. He had provided a sufficient sum to have either.

By the Inspector—A big city's lighting must be laid down on such a basis that it would extend. One way of getting the wayleave for these mains outside the jurisdiction of the Corporation was by the consent of the local authorities; another was to lay the mains, and then he understood the local authorities could not take them up again.

The inquiry was resumed the following day, and Mr. Hammond gave further evidence, after which

Mr. S. Z. de Ferranti was called. He said that he had considered Mr. Hammond's scheme fully, and had been over the ground and over the site of the proposed generating station. He approved of the scheme, and considered it capable of giving light to the city on the most commercial basis. The reasons for having generating stations outside large centres of population were sound and practical, and were recognised, and that course was followed all over the world. When it was adopted by engineers and authorities generally everywhere, it proved that the idea was sound. The Pigeon House site was superior to any they could get in the city, even supposing that the Corporation owned a site in the city. It had the great advantage of a good situation for landing purposes and of a large supply of water for condensing, without the difficulty of having to take pipes into the river or the sea. They could also house their workmen in the neighbourhood cheaply and at a reasonable distance from their work. The site was an existing property, and no further money had to be sunk by the Corporation, so that the balance of advantage was largely in favour of adopting it. The cost of producing would be as low as it was possible to obtain anywhere. The system was three-phase high pressure generation and transmission to distributing centres. With regard to Fleet Street station, it was suitable for distribution but not for generation. The system for lighting was as good as one could reasonably wish. To his mind, it was absolutely as good as any other. Broadly speaking, it was the most economical way of supplying the city with light and power. After a good deal of cross-examination

Mr. W. M'Cabe, assistant waterworks engineer to the Dublin Corporation, in answer to Mr. Day, said he had made borings in the Pigeon House Fort, and all round in connection with the main drainage scheme about the year 1893, and he had no doubt as to the foundations being suitable for a proper electric light station.

Mr. Mark R. Ruddell, electrical engineer and electrical superintendent for the Dublin Corporation, was examined by Mr. Bushe. He referred at length to the manner in which the electric lighting system in Dublin had worked from its establishment. Regarding the present system, he stated that if applications for supplies continued as they had been coming in, the full capacity of the station would be very soon reached. The proposed system would be, he believed, a profitable business.

When the inquiry was again resumed on Thursday, Mr. Healy called Mr. Harty, the city engineer, to give evidence with reference to the nature of the foundation of the Pigeon House site.

Mr. H. H. Hillis, resident engineer employed in connection with the Main Drainage Works, gave evidence as to the depths at various parts of the harbour of Dublin for the purpose of showing that they were sufficient for the carrying out of the scheme.

This closed the Corporation case.

Mr. Healy stated the case for the opposition. The loan was for trade and competitive purposes. Why should not the Corporation under such circumstances go into the open market for the loan? They had in Dublin a strong gas monopoly. Already the Corporation had laid out £80,000 on a failure to convenience 250 people. For that expenditure the city got no value. As to the proposed scheme he submitted that it was not Mr. Hammond's scheme at all. Electrically it was Mr. Ferranti's scheme, and so far as it was a Pigeon House scheme, it was a sewage scheme. They had no earthly reason for going to the Pigeon House except that they had a sewage scheme there, and because they said they owned land there. The Corporation, he maintained, had no power to expend money outside its area of supply. The proposal was to compulsorily rip up the Pembroke roads, and adopt them for the purposes of the Dublin authority, and the same with regard to the County Council. Notice of the proceedings should have been given to these bodies, and the proceedings, counsel argued, were *ultra vires* on that ground alone. As regarded the undertaking of the scheme itself, he said that the tramways company, for instance, which was engaged on the traction business, and which had to keep open its works for 14 hours a day, could easily take on the few extra hours, and do the work. Having entered into the details of the scheme, counsel went on to express doubts as to the security which

a period of two hours, followed by the application of water. Two

last week, it was stated that the agreement with the British Electric

the Corporation would be able to offer for the repayment of the loan. The inspector should see if the purposes for which the money was borrowed would be of themselves reproductive. So far as concerned the item of coal in connection with the estimated cost, he said that at a time when Dublin was paying 29s. for coal, Mr. Hammond based his estimate on a 15s. price. The scheme was an absurd one, on which public money ought not to be lent; it was unsound financially, and unscientific electrically, and the Corporation and the citizens could, at much less expense, secure for themselves the light which many of them desired.

Mr. Arthur Wright, consulting engineer to the Brighton Corporation, was examined by Mr. Day. He said that he had gone into Mr. Hammond's scheme, and considering the circumstances of Dublin, he believed that it ought to have electricity distributed on the continuous current system, as it was easier to handle, cheaper to produce and distribute, more generally applicable to the wants of the lighting consumers and motive power users, and capable of giving a more reliable and constant service than the alternating system. In several places that he knew, the continuous system had been substituted for the other, and with good results. He imagined there must be nearer water sites than at the Pigeon House. That was not the only place in Dublin where you could get water and get coal landed. If a nearer site was available it would mean a great saving in expense for mains, and he could not imagine any extra cost in coal that would be incurred by coming nearer to Dublin. Fleet Street made a capital distributing centre. If Fleet Street was the distributing centre, practically all the sub-stations would not be necessary. The proposed system was more expensive in installation and maintenance than the continuous current system. Witness disagreed with Mr. Hammond as to the amount of capital required. It seemed to him to be quite inadequate. It was unnecessary to try this huge experiment at this date in electrical progress.

Sir George Moyers, who was next examined, stated that he had recently visited the Pigeon House site. The buildings exhibited several cracks. They were built very solidly, and with great care, but still there were a number of settlements in them with cracks. In one case there is a very considerable crack between the ordnance store and the main building of the Pigeon House Fort, where it was 2 or 3 inches out of plumb. He considered the £20,000 totally inadequate for the erection of the contemplated power station.

On 30th ult. Mr. Thomas Tomlinson, B.E., was examined by Mr. Day. He had made an examination of Mr. Hammond's scheme before he had known he was to be examined as a witness, and his opinion was that the scheme, on the whole, was not a suitable one. The two-phase system of distribution would have got over certain anomalies, and would fit in better with the existing system. It would obviate the use of step-down transformers at Fleet Street. A two-phase distribution to the customer was adopted in the only two big electric distributing stations lately erected in London. He knew that the Pigeon House site was originally in the sea, and that it was simply a sand bank, and the probability was that it was a sand bank on the old alluvial drift from the river. He inspected the buildings at the Pigeon House Fort, and his opinion was that the foundation there would not be sufficient to sustain the buildings proposed to be erected there, with the rotary and other machinery. He knew that sand kept in its place was one of the best possible foundations, but mud was different.

Mr. Arthur Edward Porte, M.I.C.E., was next examined by Mr. Day. He stated that he had some experience in getting foundations along the Liffey, along the southern bank particularly. In three cases they had sought for foundations for the National Telephone Company's works. In the first case they went down 12 feet 6 inches, and the test bar put into the ground simply disappeared, and in order to get a reasonably good foundation they had to float in about 100 tons of concrete and isolated from the building. In the second case they went down 15 feet without finding bottom, and in another case they went down 9 feet, and the test bar could have been shoved down with the hand. It was black mud in these cases. His contention was, that as this was all made ground, formerly the estuary of the river, the probability was that after they had got down to the sand they would come to the bed of the river, as they did in those cases. As a ratepayer, he wanted to see that if they were going to embark on a scheme like this they were not going to throw £40,000 or £50,000 into a useless foundation. If the Pigeon House Fort was of this character it would be suicidal to erect the proposed buildings upon it, and if they came to black mud, as they did, he should say that Mr. Hammond's estimate of £20,000 would go a very short way upon it. With regard to the proposed 500 arc lamps, he thought that under the circumstances that would be an extravagant number for a city of this class. He thought it was unwarranted and unnecessary. He had extensive experience as an electric lighting contractor in Dublin, Cork, and Youghal, and he believed that the average opening hours for shops in Dublin, the burning hours were 220 in the year. And if they applied the Wright system the consumers would derive no benefit whatever from the sliding scale. On the contrary, they would be paying more than, or as much as at present, and, therefore, if the 4½d. was to apply to Dublin at all it should apply to those who had to pay the largest rates. His general opinion was, that looking at this scheme as a whole he did not think that a suitable provision had been made for motor work. He thought that if they took other towns and compared the motor work that had been done in them they would find that no provision whatever had been made by Mr. Hammond's scheme. Further, he said that general experience showed that beyond yea or nay alternating current motors, on the single-phase system, had not been taken up. His experience was that there was no comparison as regarded the demand between the alternating current system and the continuous current system. In his opinion, if there was a continuous supply in Dublin there would be a large demand for motor cars.

Cross-examined by Mr. Whit: He had not been connected with central station work for many years as a running engineer. He never was a consulting engineer for any large scheme, and never drafted any large scheme. He was one of the engineers connected with the erection of the works in Fleet Street.

Mr. Henry, assistant town clerk, then proved that he received on March 27th a letter from the Tramway Company to the town clerk dated March 26th. The Tramways Company had made a previous offer to the Corporation with regard to electric lighting in a letter dated November 29th, 1897. Mr. Henry read both these letters.

Mr. Horace Parshall was then examined by Mr. Healy. He was connected with the early working of the three-phase system in America, and they (the Dublin Southern Tramways Company) were the first to put in the three-phase system in these countries. The three-phase system was used for transmission, but never for distribution. He was connected with the Niagara Cataract Construction Company. They wanted to send electricity to Buffalo, some 20 miles odd distant, and the question arose whether they should get the supply from a three-phase or quarter-phase network, and the three-phase system was thrown out because it would not balance. There was no distribution in America, except by direct current. The quarter-phase current was transmitted to Buffalo and there transformed. He knew that the city trams in Montreal were worked on the continuous system on the bulk of the road. He was acquainted with Prof. Silvanus Thompson, and considered him a good teacher and writer, but if Prof. Thompson had stated that the continuous current was a thing of the past for electric traction, he should say that that was absolute rot. They were not driving a car in Dublin at present, except by the continuous current, and they were putting down an installation of 900 in Glasgow on the same system.

Mr. Bushe pointed out that Prof. Thompson's statement was contained in a presidential address, and was to the effect that the continuous current would not work motors at all, except toys of the old Barlow wheel type.

The witness expressed his dissent from that statement, and said he could speak with some authority on the subject, as he had designed more dynamos than Prof. Thompson had ever seen. All the big lighting companies were going in for continuous current as far as they could. There was no question that if they reduced the periodicity to 50 the single-phase motor became a more efficient machine, but he doubted whether he would call it an efficient machine compared with the commutating machine. His experience was that the wooden troughs for cables had to be dispensed with, as when one cable burned off they nearly all burned off, and thus the whole system was crippled.

Mr. Bushe said the high pressure cables would be laid in iron culverts.

The witness, in reply to further questions, expressed his disapproval of having the generating station outside the area to be supplied. There were plenty of sites to be had along the quays. In reference to the Ringsend station, he said it cost about £125,000. Since its erection they had put in six engines of 750 H.P. at a cost of £3,600 each. These engines would now cost £5,500 each. The price of steel, copper, and cement had also greatly increased. Practically, the Ringsend station was working at all hours. Just now they were generating there at the rate of 6,000,000 units per annum. He had seen for the first time that morning that the tramway company had made a bulk offer to supply power to the Corporation at Ringsend, leaving the monopoly of distribution with the Corporation. He should not bother with the offer at all. He did not think that business on that basis was good enough to go on with, and would bring in a less return than their ordinary undertaking. He was not in favour of the first offer at all. In time the second offer, he thought, would be a profitable business.

In cross-examination by Mr. Bushe, the witness said he did not think that undertakings of this sort carried on by municipalities were always successful. Questioned in some detail on the matters mentioned in Mr. Hammond's report, he said he had considered this report of Mr. Hammond's with a number of experts, and none of them could make head or tail of it. In reference to the defects of Mr. Hammond's scheme that he did not think they would be justified in going out to the Pigeon House Fort, and he would make the system a continuous current system almost throughout.

Mr. Thomas J. Cotton, public lighting inspector and city gas engineer, was examined, and Mr. Day then addressed the inspector in opposition to the proposed scheme. Mr. Bushe having replied for the Corporation, the inquiry concluded.

Halifax.—The Town Council has resolved to reduce the charge for electricity for lighting purposes from 5d. to 4d. per unit, with the present scale of discounts, and for tramway supply from 2d. to 1½d. per unit.

Inverness.—A special meeting of the Town Council was held on 14th ult. to consider a report by Mr. Craven, electrical engineer, on the offers for the electric light installation. Three offers were considered by the meeting. The Council decided to accept the lowest offer, of £21,060, from the Brush Electrical Engineering Company, London. This offer included everything with the exception of the outlay for the erection and the laying of the foundation of the station house, and the opening and closing of the trenches in which the cables are to be laid. It is understood that the works will be proceeded with as soon as possible.

Leatherhead.—At a meeting of the District Council last week the Lighting Committee reported the receipt of a letter from Messrs. Handcock & Dykes, offering to take a lease from the Council of the powers conferred upon them under their order for 42 years at the annual rent of £15, subject to a right of pre-emption at the end of 25 years, or any succeeding five years, at its then value, together with a sum to be awarded by the arbitrator, representing the good-

serve all the present carefully spent money.

Witness, in answer to further questions, spoke of a number of hours, and do the work. Having entered into the details of the scheme, counsel went on to express doubts as to the security which

will for the number of years then unexpired of the original term of 42 years. The Council accepted these terms subject to the consent of the Board of Trade, and to the lessees paying all the expenses of the Council incidental to the lease, and to the terms of such lease being hereinafter agreed upon, and to the lessees' accounts being open for inspection by the Council.

London.—The City of London Company.—The scale of charges for electricity supply has been once more revised, the company no doubt finding that to supply lamps which are used for very short periods at the uniform rate of 4½d. per unit is far from a profitable undertaking. In future the price will be 8d. per unit for the first 12 units per annum per 8-c.p. lamp fixed (or its equivalent), after which the price will be 2d. per unit. The company candidly states that the effect of the new system will be to benefit the long-hour consumers, whereas those customers who use their lamps "very occasionally," and then only for short periods, will have to pay a more equitable proportion of the cost of supplying them. 12 units per annum are approximately equivalent to one hour's average daily use of an 8 c.p. lamp.

This is undoubtedly a step in the direction of a fairer apportionment of the cost of production and distribution, but the system tends to discourage the installation of numerous lamps on consumers' premises, and in this way may have a prejudicial effect on the company's turnover. We shall not be surprised if, later on, the maximum demand system is adopted; certainly, in our opinion, this will be of the greatest benefit to the company.

Hampstead.—The Vestry has reduced the charge for electricity supply to 6d. per unit for one hour's use per day of the maximum demand and 2½d. afterwards.

Whitechapel.—At their last meeting the Board of Works decided to obtain a loan of £4,000 from the London County Council for the purpose of erecting a new dust destructor, the waste heat of which is to be used in the electrical generating station.

Poplar.—A commencement will be made in the work of laying the mains in the course of a few days, and a great development of the original scheme is proposed by the Electricity Committee, which is recommending the District Board to light 13¼ miles of side streets by electricity. Altogether the expenditure of these two districts will amount to close on £200,000.

Newington.—The Vestry has passed the following resolution in connection with the recent conference of local authorities at Islington:—"That in the opinion of this Vestry the London County Council, as the sanctioning authority for the raising of loans, are justified in requiring such information from the local authorities in their applications for electric lighting loans as would prevent the inclusion in such applications of works covered by former loans, or of charges of the nature of revenue; and that a copy of this report be forwarded to the Council."

Lowestoft.—The Council is, on Mr. Hawtayne's advice, sending a deputation to a number of towns to ascertain the prices charged and arrangements made for electric lighting.

Monmouth.—The Town Council is seeking power to borrow £28,000 to complete the drainage and electric lighting scheme.

Provisional Orders.—The Board of Trade has, under the powers conferred upon it by the Electric Lighting Acts, granted provisional orders for the supply of electricity within their respective areas to the Corporations of Basingstoke, Newark and Penzance and the Urban District Councils of Brierley Hill (Staffordshire), Cleethorpe (Lincolnshire), Elland (Yorkshire), Erdington (Warwickshire), Exmouth (Devonshire), Farnham (Surrey), Leek (Staffordshire), Littleborough (Lancashire), Maryport (Cumberland), Nantwich (Cheshire), Ormskirk (Lancashire), Penrith (Cumberland), Prestwich (Lancashire), Redcar (Yorkshire), Sowerby Bridge (Yorkshire) and Whitefield (Lancashire).

Rotherham.—On behalf of the Local Government Board, Mr. E. A. S. Fawcett last week conducted a public inquiry into the application of the Corporation for power to borrow £27,969 for electric lighting purposes. The direct current three-wire system will be adopted, provision being made for 35 arc lamps for street lighting and 10,000 glow lamps of 8 c.p. It was also mentioned that the Corporation are seeking Parliamentary powers to run electric trams.

St. Helens.—The St. Helens Parliamentary Committee, at their last meeting, came to the decision to recommend the Town Council to withdraw from the Conference of Municipal Corporations of Lancashire. The step is taken on the understanding that the clauses for the protection of boroughs will be inserted in the Lancashire electric power Bill. These clauses make the Council's consent a condition in respect of the route of "through cables" and the supply within the boroughs; the St. Helens Town Council will, therefore, act independently in this matter, and will not oppose the preamble of the Bill.

Springfield Asylum (N.B.).—The committee appointed by the Fife and Kinross Lunacy Board to make investigations and report as to the advisability of introducing the electric light into the Asylum at Springfield, is satisfied that it would be much cheaper and a better light than the present gas supply from Cupar. The committee is to ask powers from the Lunacy Board to obtain estimates from electrical engineering firms for the installation.

Sudbury.—In the House of Commons on Friday night last Mr. Ritchie brought in a Bill to confirm a provisional order which had been made by the Local Government Board under the Electric Lighting Acts as to Sudbury.

Todmorden.—The Town Council has appointed Messrs. Medhurst & Page, of Manchester, to report on electric supply works for the purpose of lighting, electric traction, and motive power within the borough.

Tunbridge Wells.—The Local Government Board has sanctioned the Corporation loan of £24,682 for electric light extensions.

Walker.—The District Council has come to terms with the Newcastle-on-Tyne Electric Supply Company regarding their Bill as amended.

York.—The Corporation electricity works were taken over by the city on Monday, and commenced regular working. The progress of the lamp connection has been so rapid that the station is already fully loaded, and the Council on the very first working day agreed to apply to the Local Government Board for permission to borrow £20,000 for extensions. The original outlay was also £20,000.

ELECTRIC TRACTION NOTES.

Barrow.—At the last Council meeting a letter was read from the British Electric Traction Company, applying for permission for the adoption of electric traction on the tramways in the borough, of which the company have now had possession for three months. It was decided to refer the matter to the surveyor, and to call the company's attention to the state of several of the steam engines which required improvement.

Birmingham.—A public meeting is memorialising the City Council in opposition to the proposed use of the overhead trolley on the Bristol Road.

The speeches and voting at the City Council on Tuesday showed that a far more reasonable spirit now exists in regard to the electric tramway question. Certain proposals submitted by the Tramway Company are to be fully considered, and a resolution passed two years ago declining to further negotiate with the company has been rescinded. The Lord Mayor, whose speech showed a certain grasp of the subject, thought that the overhead trolley might be used for outlying streets, &c., some other form of electric traction being utilised in the central thoroughfares.

Cuba.—The new electric street tram service was opened about three weeks ago.

Edinburgh.—The Board of Trade inspection of the Grange and Churchill cable car routes took place last week, and at the luncheon which followed, Bailie M'Kenzie made a significant remark which is regarded somewhat seriously by one of the local papers as indicating that conversion from cable to electric traction may not be so far off as some people may think. He said: "Electrical engineers seemed to be coming round to the view that electrical motors in the cars was the ideal traction for the future; and possibly by the time the lease of the Tramway Company was up, electrical motors would have been so improved that the Corporation would then adopt them."

Gloucester.—Councillor Hatton thinks that now that the Corporation has been spending large sums in improving the streets, which had been added to in an architectural manner by tradesmen, it would be unwise to render the streets unsightly by sanctioning the overhead trolley. He said that the conduit system was being substituted for the trolley in a main street in Japan, and Japs were not fools, and so on. Happily, however, Councillor Bland reminded the Council that they need not go so far as Japan for an opinion, seeing that the Birmingham Corporation were at the present time proposing to adopt the overhead wire.

Ilford.—The District Council have received formal sanction from the Local Government Board to a loan of £70,000 for electric lighting and electric tramways.

Italy.—The Rome correspondent of the *Morning Post* says that within a short time electric traction will be adopted on the Giovi line, on which lies the famous Giovi tunnel, in which many railway accidents have occurred through the asphyxiation of engine drivers by the sulphurous fumes from the engines. As the Giovi tunnel has a very steep gradient, and as the traffic has augmented too rapidly to allow satisfactory ventilation by any known system, the railway authorities have decided to introduce electrical traction between the stations of Mignanego and Ronco, where a 700-volt current will be transferred from the generating office to the motor cars intended to replace steam engines for the service on the line. These motor cars will be of 544 H.P. for goods trains and 840 H.P. for passenger trains. This is an exceedingly important innovation, which, if extended to the other dangerous tracts of line in Italy, would greatly increase the safety and the comfort of travellers.

Kirkcaldy.—In connection with the tramway and electric lighting schemes a committee of the Town Council has been appointed to visit several towns in England of about similar population to Kirkcaldy with the view of reporting financially and otherwise on the working of tramways in those towns.

(*Continued on page* 581.)

Cross-examined by Mr. Whit : He had not been connected with

or 25 years, or any succeeding five years, at its then value, together with a sum to be awarded by the arbitrator, representing the good-

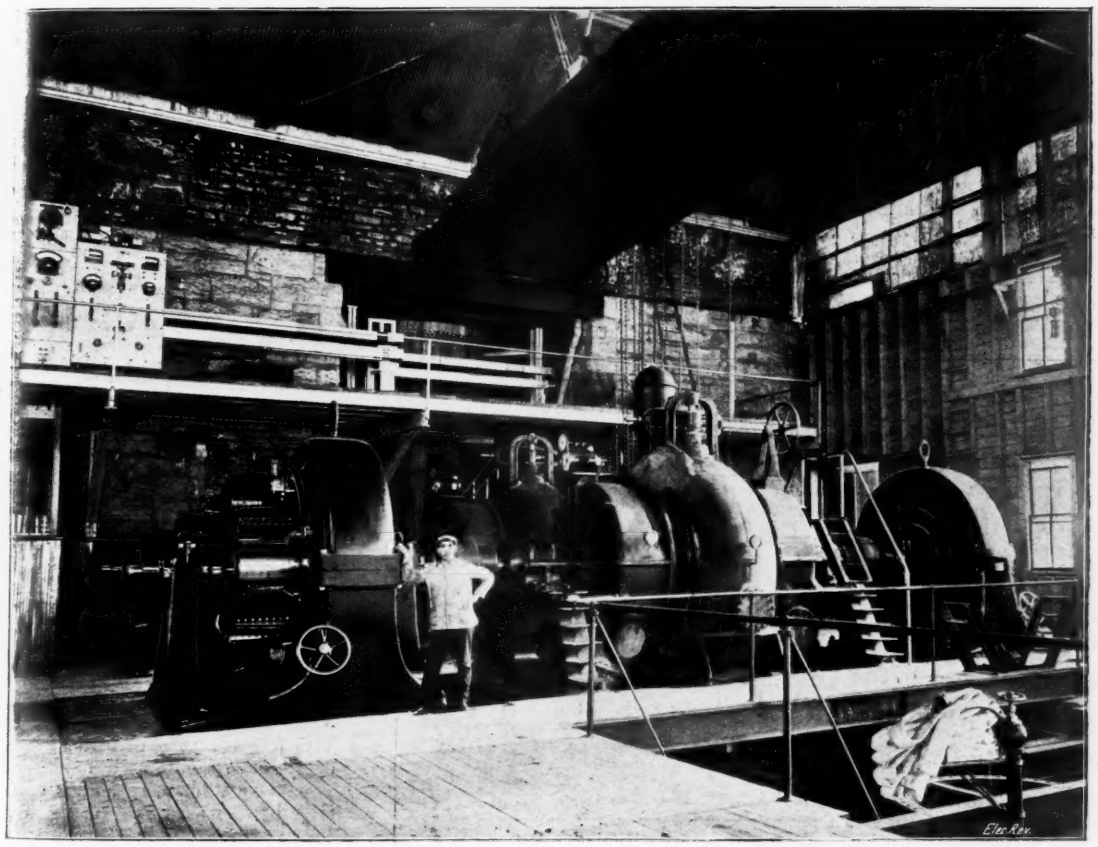
NEW TURBINES AT NIAGARA.

The oldest water wheel in existence at Niagara Falls to-day was installed in 1848 to operate a grist mill on the high bank between the two great railway bridges. The wheel is located right at the head of the whirlpool rapids, where an early-day settler recognised there was a possibility of securing sufficient power to operate his mill. In its best days this wheel gave about 100 H.P., but for the past five years it has practically been out of use, owing to the fact that the construction of the Gorge railroad interfered with its operation. The matter is now in the Courts, and the owner of the mill has had several decisions in his favour.

This old wheel forms a strange comparison with the modern 5,000-H.P. turbines in operation in the wheel pit of the Niagara Falls Power Company. Together, they represent the earliest and latest practice and use in the development of the greatest source of power in the world, and for this reason they are indeed doubly interesting. It is exceedingly interesting to compare the old oak shaft of the ancient wheel with the steel tube shaft of the modern turbine. While the old water-wheel has had many repairs made to it in its day, the old shaft originally placed is shown on the next page, and is solid after a half century of use. The old water-wheel might be referred to as of mongrel type, being of central discharge reaction pattern. The method of transmitting power from this old wheel to the mill on the cliff was by means of a wire cable extending up the debris slope of the cliff.

At the point where the old mill is located there is an inclined railway, affording tourists an opportunity to view the whirlpool rapids from the water's edge. Steps are now being taken to remodel the power resources of this elevator, and by next spring it will be operated by electricity, which will be supplied by one of the large plants at the Falls.

In order to secure electric current for the operation of the increased number of pots placed in their lower works at Niagara Falls, the Pittsburg Reduction Company has recently installed four 750-KW. generators of Westinghouse make in the station of the Niagara Falls Hydraulic Power and Manufacturing Company, where they are connected to two turbines. Each of the turbines is of 2,500 H.P. capacity, and they are of R. D. Wood & Co.'s make. The two turbines and connected generators are well portrayed in the accompanying illustration. The turbines are supplied from the latest and largest penstock, and have been placed over the first two valves on the penstock. The open space in the foreground to the right will be the location of the two new turbines now being made by the I. P. Morris Company, of Philadelphia, for the Niagara Falls Hydraulic Power and Manufacturing Company, and when these machines are in place, there will be three makes of turbine in the station. The original turbines were made by James Leffel & Co., of Springfield, Ohio; the next by R. D. Wood and Co., of Philadelphia, and those to come, as stated, will be made by the I. P. Morris Company, of the same city. In the illustration, in the background over the machines, is to



New Turbines at Niagara Falls.

G

had been made by the Local Government Board under the Electric Lighting Acts as to Sudbury.

working of tramways in those towns.

(*Continued on page 581.*)

be seen the penstock as it descends from the cliff top, and in front of it pass the aluminium bar conductors. The switchboards of the station are on the gallery, seen in the background.

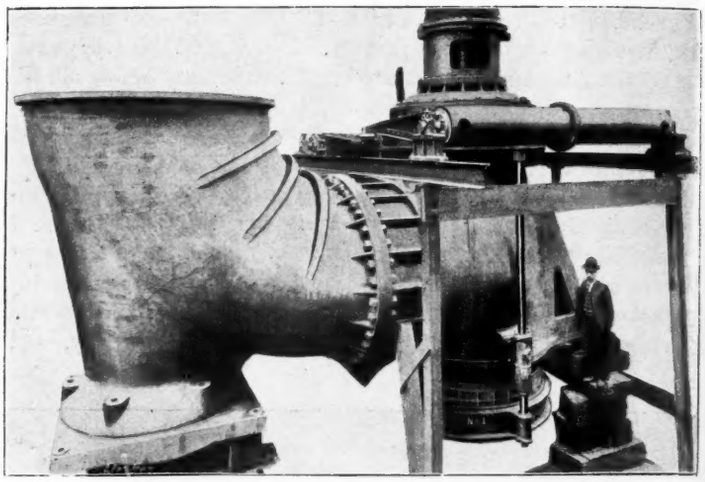
Outside, to the right, men are now busily engaged in erecting the third section of this power house, and when the installation of that section has been placed, the capacity and size of the power house in the original designs and plans will have been attained.

WATER-POWER FOR ELECTRIC TRACTION IN THE ISLE OF MAN.

The Isle of Man Tramways and Electric Power Company, Limited, recently put into operation a water-power plant in connection with their Douglas, Laxey, and Ramsey electric system. The successful results obtained have enabled them to shut down their steam plant entirely, and the line, which is 18 miles long, is now being worked solely by water-power.

For the following notes regarding the new works, and the illustrations which accompany them, we are indebted to the *Tramway and Railway World*, who have courteously lent us the blocks:—

The line in the summer time is used for tourist traffic, when the load on the various power stations reaches about 2,200 H.P., but for about seven months each year the line is dependent on the local passenger and freight traffic, which is comparatively light. The water-power scheme, which was originated by Mr. Alexander Bruce, J.P., the chairman of the company, was designed by Mr. J. Shaw, A.M.I.E.E, the general manager and engineer, to work the line during these seven months when the receipts are considerably reduced, and it is necessary as far as possible to keep down the expenditure. As all the coal used by the company has to be imported from South Wales, the saving will be considerable.



New Turbines at Niagara.

The Old Shaft, Niagara.

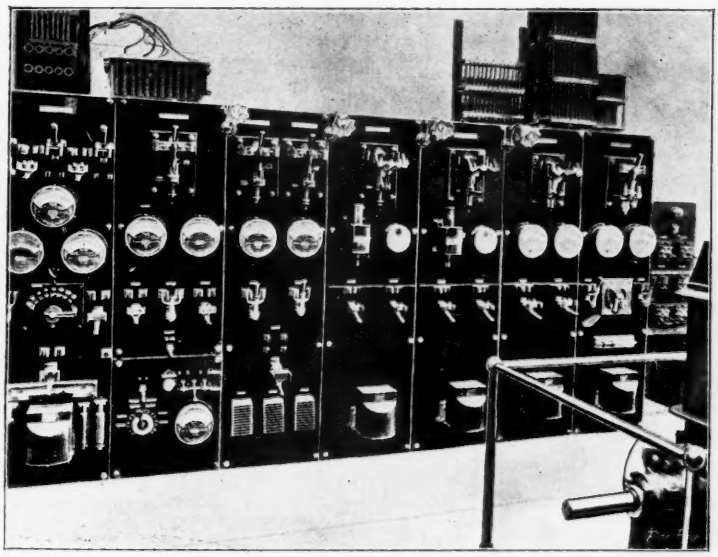
The Laxey river, which is 7 miles from the Douglas and 11 miles from the Ramsey terminus, has been utilised for obtaining the power. The water has been taken after leaving the washing floors of the Great Laxey Lead Mines, and the tail water is discharged direct into Laxey Harbour, the total fall being 41 feet, which, after deducting pipe losses, &c., allows a working head of 38 feet. As part of the water is used for washing purposes at the Snaefell and the Great Laxey Mines, it contains an immense quantity of sand, and special precautions have been taken to prevent this from reaching the turbines.

The head work consists of a concrete weir 40 feet long by 4 feet 6 inches high, built across the river. At one end of the weir are two masonry archways, 5 feet wide × 5 feet high, each fitted with a sluice gate and the necessary gear for raising and lowering it. The two gates are separated from the river by means of an iron grating 55 feet long × 5 feet 6 inches high. During floods a large amount of *débris* is washed down the river, and the gratings protect the gates from being blocked. Inside the gratings is a large settling tank for the sand, which is emptied by opening the gate nearest the weir which is used as a bye-pass for flushing purposes. The other gate is at the commencement of the head race, which consists of 826 feet of trench, 5 feet wide, and 474 feet of trench, 3 feet 6 inches wide, the depth of each being 4 feet 6 inches.

The first section was made with a larger area to allow the water to travel slowly, and settle sand which might have passed through the first settling tank. At the end of the larger section of the race another settling tank has been formed by dropping the bottom of the trench 6 inches for a distance of 50 feet, and providing it with a 12-inch flushing valve. At the end of the second section of race is built a

masonry head box 8 feet × 11 feet × 7 feet 9 inches deep from which the water is conveyed to the turbines by means of 820 feet of steel pipes, 3 feet 6 inches diameter. The head box has also been built to act as a settling tank, and prevent any sand entering the pipes. An overflow weir 20 feet long has been built about half-way along the race, the surplus water being conducted to the river by an underground conduit. Owing to the rocky nature of the ground the whole of the head race has been constructed of concrete with the exception of one short length which was built of masonry. The pipe line, which had to be kept several feet above the ground, is supported on masonry piers. The pipes are made up of ⅛-inch steel plates with double riveted seams, and fixed in 15 feet lengths. The joints are made with Kimberley collars run in with lead, and well caulked.

The tail race is 624 feet in length, 10 feet wide, and 13 feet 3 inches below the floor of the turbine house, and terminates in Laxey Harbour. The turbine house is 1,100 feet away from one of the company's steam power stations, and is a stone building 30 feet long × 16 feet wide × 12 feet high. The fall from the level of the weir to the centres of the turbines is 26 feet, the remaining 15 feet fall being obtained by means of draft tubes. The turbines are of the Victor horizontal type, and consist of two independent 12-inch turbines in one casing with the shafts direct-coupled, so that when there is only a small amount of water available, one turbine will be used, which enables the plant to be worked at its best efficiency. The turbines will develop 140 H.P. at a speed of 720 revolutions. The generating plant consists of a combined bipolar generator and booster, the generator having an output of 160 amperes at 520 volts, and the booster 160 amperes at from 100 to 200 volts. The generator and booster are coupled to the turbines by means of a friction clutch, which permits of the plant being used as an ordinary motor-driven booster in the summer time when the river is very low. The turbines, generator, and booster are provided with self-lubricating bearings, and are capable of maintaining long continuous runs without heating. The mains from the generator and booster and the regulating wires are carried overhead to the steam power station previously referred to, from which the turbine plant is entirely controlled. Two Lundell ¼-H.P. motors, driven from a small storage battery, are used to open and close the turbine regulators. The switch panels for the generator and booster are attached to the main switchboard in the steam station, and consist of one generator panel with automatic switch, ammeter, voltmeter, positive and negative switches, shunt regulating switch, starting switch, and resistance to work the generator as a motor for driving the booster when the water is low, and an integrating wattmeter.



Main Switchboard in Steam Generating Station with Panels for controlling Turbine Station.—Isle of Man Electric Tramways.

The booster panel contains switches for controlling a motor-driven booster in the steam station, and also the switches for controlling the turbine booster, that is, positive and negative switches, voltmeter, ammeter, shunt regulating switch, integrating wattmeter, and change-over switches to connect either the turbine booster or motor booster to any of three feeders. Adjoining the generator panel is a small panel for controlling in either direction the two ¼-H.P. motors for regulating the turbines. A small pipe has been carried from

Weir and Head Race in Laxey River.

Above the Weir—Gates to Head Race on the Right.

the head race and is attached to a gauge glass fixed in a prominent position near the switchboard so that the attendant can see the height of the water in the head race.

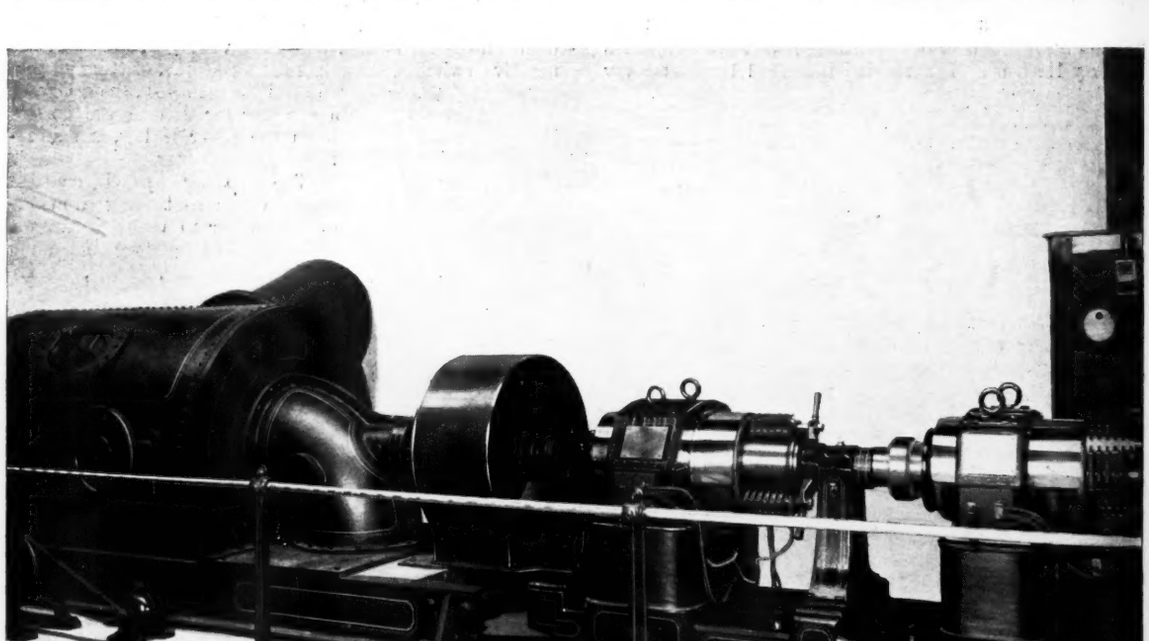
The turbine plant is worked in connection with three battery sub-stations, each containing 250 cells of the

Pipe Line and Turbine House.

Chloride R type, one at Laxey at the foot of the Snaefell Mountain Railway, and the other two about five miles on each side, all the stations being worked in parallel. When the cars are taking current, the turbine generator is assisting the batteries, but when the cars are descending the grades or standing the generator is charging the batteries. During the night-time when the cars are not running the booster is connected in series with the generator, and the batteries are in turn charged at a heavy rate and at a high voltage through the underground feeders. This enables a full load to be maintained on the turbines continuously. This company was the first in the country to use storage battery sub-stations for traction purposes, and they have proved exceedingly useful for working a long line with a minimum amount of generating plant. The turbine plant has just completed a 240 hours' continuous test, during which it maintained a steady load varying from $\frac{3}{4}$ to full load, and although the turbines are not provided with any governors, it was not necessary to alter the regulation once.

The turbines and pipes have been supplied by Mr. F. Nell, of Queen Victoria Street, London, and the generator and booster by the Electric Construction Company, of Wolverhampton. The construction of the weir, water courses, and buildings, and the erection of the plant, have been carried out by the company's staff under the superintendence of Mr. J. Shaw, general manager and engineer.

Hydro-electric Power Production.—It is proposed to transmit power from Beaver Creek, about 10 miles from Victor, to the Cripple Creek district for operating the reduction works of the Gold Coin Mining and Leasing Company. The water-power available is 5,000 H P., and will be conveyed in some 6,000 feet of pipe. The head is 2,300 feet, and it is intended to divide this between two generating plants, consisting of Pelton water-wheels, 69 inches in diameter. The first set of wheels will be placed at such an altitude as to admit of a head of 1,100 feet; the water will then flow down to the second set, 1,150 feet below. The pipe line for the first plant is now in course of manufacture, and will be of sheet steel riveted, 3,200 feet in length, and 29 inches in diameter, the steel varying in thickness from $\frac{3}{16}$ to $\frac{5}{16}$ inch. The electric generators are manufactured by the General Electric Company, of America, and each generator will be connected direct to two Pelton wheels, having an aggregate capacity of 675 H P. The wheels and generators will be mounted on separate base plates, and the shafts will be connected by means of combination fly-wheel couplings.



Turbine, Dynamo, and Booster—Laxey Turbine Station, Isle of Man.

plant consists of a combined bipolar generator and booster, regulating the turbines. A small pipe has been carried from

ELECTRIC TRACTION NOTES.

(*Continued from page 576.*)

Liverpool.—The accounts of the Corporation Tramways Committee for the year ended December 31st last, issued on Saturday, have been awaited with a good deal of interest because of the many changes made in routes besides the gradual substitution of electrical for horse traction and the reduction in the fares. The aim of the late Sir A. B. Forwood, when he was promoting the electrical undertaking, was to have uniform penny fares on all routes for any distance. Alderman Petrie, the present chairman of the Tramways Committee, recently made a speech, in which he contended that the universal penny fares would not pay, and would involve the levy of a tramway rate. On the other hand, Councillor Rutherford, who some time ago retired from the chairmanship, offers on the part of a syndicate, to pay £100,000 down as bonus for a 30 years' lease of the tramways, and to give a guarantee of £250,000. He undertakes to charge only a penny for any distance, and to prevent overcrowding, which is now a continual source of complaint. He also undertakes to pay off the Corporation debt on the tramways, which exceeds £1,000,000, to extend and complete the electrical equipment of the lines throughout Liverpool, to take the necessary power from the Corporation at present prices, and to hand over the whole system complete, and in excellent working order, on the expiry of the lease. The Tramways Committee have not yet taken any steps in regard to Mr. Rutherford's formal and detailed offer. The controversy, says the *Times*, lends interest to the Committee's accounts just issued. The revenue from the horse trams was £230,411; from omnibuses, £50,547; realised for manure, £3,237. Adding proportion of receipts for advertising in cars makes something like £290,000. The working expenses of all sorts were £242,392, leaving an apparent profit of £47,708, out of which must be met interest and sinking fund and capital, besides the great depreciation involved in the gradual change of traction. The electric tramcar revenue was £77,663 and the expenditure £36,973, showing a profit of £40,690, or more than 50 per cent. of the receipts. But the charge made to the tramways for electric power is less than to ordinary consumers. Some general charges added to the other disbursements make the aggregate expenditure £302,159, the income being £365,859, leaving a balance of £63,700. The capital account shows that the purchase of the undertaking of the late Liverpool United Tramways and Omnibus Company, Limited, cost £596,548 (the lines already belonging to the Corporation). The total expenditure on the lines up to the end of 1898 was £257,821, on tramroads for electric haulage the expenditure was £172,301, nearly all in 1899. Altogether the expenditure on capital account has been £1,161,279, of which £244,756 was spent last year (1899); and it is noteworthy that the assets are set down at £1,161,279, or precisely the amount actually paid for land, buildings, tramlines, horses, cars, &c., without any regard for depreciation, though it is obvious that the electrical developments will make the horses and horse cars of diminished value.

Loughborough.—The Light Railways inquiry, opened on March 19th, was resumed on Monday at Loughborough into the application of the Loughborough and District Electric Traction Syndicate, Limited, for permission to lay certain light electric railways. The Commissioners inspected the routes, and certain opposition having been withdrawn and the details discussed, the scheme met with the Commissioners' approval, with the exception of line 1, with respect to which a further application has to be made in keeping with certain conditions.

The Metropolitan Railways and Electric Traction.—At the meeting of the Metropolitan District Railway held last week to consider certain Bills to come before Parliament, Major Isaacs presided. The company's own Bill sought power to acquire land at Lot's Road, Chelsea, for the construction of a generating station, and to lay down cables to convey electrical energy from such generating station to the railway. They had come to the conclusion that probably the only way in which the railway could be turned to best account at certain times of the day would be to give up the motor which they were now using, and to apply electricity in its place. He had no doubt that proprietors had noticed that from 11 o'clock in the morning until 3 or 4 o'clock in the afternoon nothing like proper use was made of the railway by the travelling public, in consequence of certain drawbacks connected with the system. It had, therefore, been in the minds of the directors for a considerable time that the sooner a change was made in the motive power the better for the money-earning capacity of the line. In the course of a few days the first trial trip by the directors would be made from Earl's Court Station to Kensington High Street on the experimental electrical section, and back again, and it would be submitted officially to the Board of Trade on the following day.

We understand that the directors inspected the train on Tuesday, and the Board of Trade on Wednesday.

Municipal Tramways.—In the House of Commons on Tuesday Mr. Jeffreys asked the First Lord of the Treasury whether he was aware that municipalities were now promoting Bills to construct and work tramways beyond the limits of their districts; and whether, seeing that under Standing Order 170A no powers were to be given to any local authority for construction, acquisition, or taking on lease of any tramway beyond the limits of their district except under special local circumstances, the Government proposed to ask the House to alter or abrogate the above order. Mr. Balfour, replying, thought that Bills of this kind had been passed before now, and the standing order provided that in exceptional circumstances they might be passed. He did not think that any alteration of the standing order should be contemplated, at all events until the Municipal Trading Committee had reported.

Rothwell.—The Urban Council have decided to ask the British Electric Traction Company, who have the Wellingborough Tramways scheme in hand, to extend their system, if it comes into existence, to Rothwell.

Surface Contact Traction.—Our Wolverhampton correspondent writes as follows:—"A considerable quantity of land, which adjoins the Midland Railway line at Wednesfield, close to Wolverhampton, has just been acquired by a Birmingham Company, and it is intended that it shall be used for the development of an electrical undertaking. The land, it may be stated, is close to the works of Thomas Parker, Limited, electrical engineers, and those of the Motor Car Syndicate. It has been acquired through the medium of Messrs. Thomas Bolton & Sons, and the Broad Street Metal Works, Birmingham; and it is in connection with a scheme which Mr. F. S. Bolton and Mr. Robert Brown, of that firm, are taking a very great interest in, and developments may be looked for. They have great faith in what is known as the Kingsland mechanical surface contact system of electric traction; and for the purpose of demonstrating the advantages of this system to the many public bodies in the Midlands interested in tramway traction, a temporary track is being put down upon which experiments are to be made."

Swansea.—The Electrical Committee of the Council has appointed Messrs. Kincaid, Waller & Manville as consulting engineers for the proposed new tramway at 10 guineas per day for principals, and 2 guineas for assistants. The tender of the Callender Cable and Construction Company for the cables, conduits, &c., at £12,613 2s. 8d., together with additions at scheduled price, total £13,332, was accepted; and a committee was appointed to report on the proposed prices, &c., for the supply of electrical energy.

Thanet.—Considerable progress has been made in connection with the Isle of Thanet light railways in Ramsgate and the immediate vicinity. The New Road, between Belle Vue Road, Ramsgate, and Gladstone Road, Broadstairs, is now being laid out. A supply of poles is on the ground.

Warwick.—The Board of Trade has granted an order to the Warwick Tramway Company for an overhead electric tramway within the boundaries of the borough. The period named is 28 years, but the Warwick Corporation is to have the right to purchase at the end of seven years. All the questions in difference have been settled except that of a rent on profits which has been demanded by the town, and which the British Electric Traction Company, which is at the back of the local company, is unwilling to concede, as it has not paid a rent on profits elsewhere.

Wolverhampton.—In accordance with the decision arrived at before the arbitrator, the Corporation will only acquire—on May 1st—those portions of the tramlines within the borough boundaries, and consequently a good deal of speculation has been indulged in by the travelling public as to how the intervening distances between such boundaries and the neighbouring townships of Bilston, Willenhall and Sedgley will be connected. It is known that the offers made some time ago by the Corporation to the local authorities in these townships, by which some arrangement might have been arrived at, were not entertained. On this point, however, the Wolverhampton Tramways Committee are at the present time in negotiation with the British Electric Traction Company on the subject. There is every probability of a satisfactory arrangement being arrived at by which the journeys by train to and from the townships above mentioned will be continued in the future on a satisfactory basis.

TELEGRAPH AND TELEPHONE NOTES.

Bradford Telephones.—The National Telephone Company has opened a new telephone exchange in Nelson Street. All the work has been done by the local staff, and in a number of cases men without previous experience have had to be trained to the work owing to the scarcity of skilled labour. Connected direct with the Bradford exchange are 1,784 subscribers, and 1,056 are connected with the 16 sub-exchanges, making a total of 2,850 telephone users, with 3,905 instruments, some firms having more than one telephone. The new switch room will accommodate 8,800 subscribers, and already plans have been passed for an extension of the switchboard to deal with another 1,000 subscribers. Most of the wires are brought into the exchange underground.

Lowestoft.—Mr. Hawtayne is to report to a Corporation committee on municipal telephones.

Telegrams to South Africa.—In the House of Commons last week, in reply to Mr. Henniker Heaton, Mr. Wyndham said:—"The Eastern Telegraph Company recently, of their own accord, reduced the charges for telegrams from 4s. to 2s. a word, and the Secretary of State for War is not prepared to call upon the company for any further concession. The number of telegrams is already so great as to lead to frequent blocks on the line."

The Pacific Cable.—The following is reprinted from the *Outlook* for March 31st:—

The Pacific Cable Board has held further meetings, but New South Wales and Victoria have yet to respond to the appeals of Canada, New Zealand, and other Australasian Colonies. They are asked to respect the spirit of Imperial partnership in which the Pacific cable project was agreed upon, and refuse the landline concessions sought by the Eastern Telegraph Company. Mr. Chamberlain is heartily with the appellants, and the official explanation issued by the Eastern Company through the *Times* quite fails to allay suspicion. The Empire has determined to lay and maintain a State cable between Canada and Australasia, and it is not playing the game for contributing Colonies to make concessions to the Eastern Company in Australia which will enable them to play fast and loose with the business of this State Pacific cable, when established. Surely, as the *Canadian Gazette* suggests, the time has come for the senior member in this new Pacific cable partnership—that is to say, the Imperial Government—to address the Eastern Company. The company will not persist in their manœuvres against the Pacific cable project when they know that to do so will imperil the good relations between themselves and the Government, from whose subsidy-bestowing bounty they still hope to receive so large a benefit.

The Telephone Service.—At Tuesday's meeting of the Council the Highways Committee submitted the following report:—

Our attention has been drawn to a letter which has recently been addressed to each member of the Council by the general manager of the National Telephone Company. Having regard to the fact that litigation is now pending between the Council and the company, we are advised that we should not comment upon the points raised in it. We wish, however, to make one point quite clear, and that is that there is a fallacy underlying the whole letter, namely, that it alleges that the company is conducting its business under a license obtained from the Postmaster-General. We have understood throughout our negotiations that the company had actually obtained this license; but we know now that this is not the fact, as proceedings have actually been instituted by the Postmaster-General to restrain the company from breaking up the streets without his license. It follows, therefore, that the Council is not yet really in a position in which it can legally grant any consent at all, nor indeed could it be advised to grant any provisional consent, until the pending litigation with the Postmaster-General has been decided. The Council cannot therefore be considered to have stood in the way of the company doing its work and improving its service. The remaining points referred to will be dealt with in the pending litigation between the Council and the company, to which we have before referred, and we refrain from making any further comment.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	June 30, 1899 ...	...
Trinidad-Demerara (1891 duplicate)	Oct. 23, 1899 ...	...
Trinidad-Demerara (1871 original)	Mar. 31, 1900 ...	...
Mole St. Nicholas-Cape Haitien...	March 6, 1900 ...	...
Cayenne-Pinheiro	Oct. 11, 1899 ...	...
Cayenne-Paramaribo	Feb. 16, 1900 ...	...
Ceara-Maranham	Feb. 20, 1900 ...	...
Para-Maranham	March 2, 1900 ...	...
Coro-Maracaibo	Mar. 15, 1900 ...	...
Latakia-Cyprus	June 20, 1899 ...	...
Sitia-Rhodes...	Mar. 17, 1900 ...	...
Tarifa-Tangier	Jan. 2, 1900 ...	...
Landlines.		
West Indies:—		
Communication with Port de Paix (Haiti)	Feb. 26, 1900 ...	...
South African:—		
Communication with Mafeking and beyond	Oct. 13, 1899 ...	...
Communication with all offices beyond Orange River	Oct. 18, 1899 ...	...
Communication with north of Mooi River (Natal)	Oct. 22, 1899 ...	...
Communication beyond Burghersdorp (Cape of Good Hope) ...	Nov. 7, 1899 ...	...
Communication beyond Estcourt (Natal)	Nov. 7, 1899 ...	...
Communication with all offices of Colombia	Oct. 23, 1899 ...	...
Communication with Colombia beyond Buenaventura	Jan. 22, 1900 ...	...
Communication "*vid* Hanekine" interrupted on Persian Territory	Feb. 24, 1900 ...	...
Coro-Maracaibo	Mar. 15, 1900 ...	...
Serena-Valparaiso	Jan. 16, 1900 ...	...

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—April 19th. The Electric Committee wants tenders for the supply of electric motors for a period of 12 months. See "Official Notices" March 30th.

Birkenhead. — April 23rd. The Corporation wants tenders for boilers, economiser, mechanical stoker, steam dynamos, condensing plant, battery and booster, and overhead travelling crane for the tramway power station. See "Official Notices" to-day.

Corunna. — April 15th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Corunna, stating that tenders are invited by the Corunna Electric Co-operative Society for the supply of a complete set of electrical machinery of 400 H.P., and capable of supplying 12,000 lamps of 10 C.P. All necessary information can be procured from the secretary, Senor Dr. Enrique Sors, 81, Calle Real, Corunna. Tenders should be addressed to the President, Senor Dr. Manuel Baifa, Calle Zafateria, No. 5, Corunna, before April 15th.

Crete.—April 7th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Canea, Crete, stating that tenders are invited by the Cretan Government, not later than April 7th, for the construction and working of tramway lines between Canea and the suburb of Halepa, and between Canea and the new Government offices. Such particulars as have been received may be examined on personal application at the Commercial Department on the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Dublin.—April 26th. The Electric Lighting Committee wants tenders for six Lancashire and four water-tube boilers and two economisers; two 1,000-KW. and two 500-KW. low speed polyphase generators for the electricity supply scheme. See "Official Notices" March 9th.

Dundee.—April 25th. The Town Council wants tenders for a traction switchboard for the electric station. See "Official Notices" to-day.

Edinburgh.—April 7th. The Corporation wants tenders for the supply of coal, arc lamp carbons, cast-iron pipes, pavement box frames, &c., for the electricity supply stations for 1900-1901. See "Official Notices" March 23rd.

France.—April 12th. The French Post and Telegraph Authorities in Paris are inviting tenders until April 12th, for the supply of 460 tons of bronze or copper wire. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et Telegraphes, Rue de Grenelle 103, Paris.

Germany.—April 20th. The Prussian State Railway authorities at Posen are inviting tenders until April 20th, for the supply of 45 tons of iron wire 4 mm. diameter, and 6,500 porcelain insulators. Particulars may be obtained for 6d. from, and tenders are to be sent to, Die Königliche Eisenbahn Telegraphen Inspection, Posen.

Glasgow.—April 18th. The Corporation wants tenders for the supply of telephone cables (including drawing into conduits and jointing); and telephone instruments (wall and table). See "Official Notices" March 30th.

Halifax. — April 7th. Tenders are being invited for electric lighting work for the Victoria Concert Hall and premises. See "Official Notices" March 16th.

Halifax.—The Electricity Committee wants tenders for a year's supply of electricity meters; and the Tramways Committee for the supply of various parts in connection with the overhead equipment of new lines. See "Official Notices" March 30th.

Mariupol.—May. The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul at Taganrog, stating that tenders are invited by the municipality of Mariupol, not later than May 16th (29) next, for the construction and exploitation of an electric tramway and the installation of electric light in that town. Particulars may be examined on personal application at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

Morpeth.—April 7th. Tenders are wanted for a complete electric lighting installation for the County of Northumberland Lunatic Asylum, near Morpeth. See "Official Notices" March 23rd.

Roumania. — April 10th. Tenders are being invited until April 10th by the Roumanian Post and Telegraph Authorities in Bucharest for the supply of 20,000 small porcelain insulators and 20,000 large ditto.

Russia. — April 13th. Tenders are being invited until April 13th, by the municipal authorities of Wilna, for the concession for the construction and operation of a central electric lighting station in the town. Tenders to be sent to Derkmagistrat of Wilna, whence particulars may be obtained.

Salford. — April 9th. The Corporation wants tenders for an ash conveyor and two electrically-driven travelling cranes, for the new electricity works. See "Official Notices" March 23rd.

Southampton.—April 7th. The Harbour Board invites tenders for a motor transformer with accessories. See "Official Notices" March 16th.

Sunderland. — April 27th. The Corporation wants tenders for the supply of two additional switchboard panels with instruments, &c., for the electric lighting station. See "Official Notices" to-day.

Walthamstow.—The Urban District Council has contracted with Messrs. F. Suter & Co., for a Dowson gas and electric lighting plant for the isolation hospital at £4,049.

Wimbledon.—April 9th. The Council invites tenders for 5,000 16 C.P., and 1,000 32-C.P. incandescent lamps. See "Official Notices" March 30th.

Wolverhampton. — The Tramways Committee of the Corporation invite tenders for steel rails and accessories required in connection with the construction of Section 1. The weight of material at present needed amounts to about 700 tons, but some 2,800 tons will be required during the next two years. All information may be obtained from Mr. J. W. Bradley, borough engineer, Wolverhampton.

CLOSED.

Belgium. — Four concerns — three German and one Belgian—submitted tenders to the Société Nationale des Chemins de Fer Vicinaux for the supply of a battery of accumulators to supply the electric energy for the light electric railways in the Liege district, the lowest being that of the Fabrik von Accumulatoren Watt, of Zehdenick-am-Havel, which quoted 26,464 francs.

Cheltenham.—The borough electrical engineer having reported that in order to supply electrical energy to the proposed light railway, the two present 100-KW. alternators should be replaced by continuous current dynamos, and that a 500-KW. steam alternator should be obtained, the tender of Messrs. Parsons & Co. of £3,820 was on Monday accepted by the Town Council.

Germany.—The East Prussian Southern Railway authorities have decided to light their railway carriages by electricity, and have placed a contract for a large number of accumulators with the Accumulatoren und Electricitätswerke Gesellschaft (Boese) of Berlin.

Roumania.—Messrs. Escher, Wyss & Co., of Zurich, have secured a contract for the supply and erection of two boilers and two engines at the Grozaresti central station, for the municipal authorities of Bucharest.

Salford.—The Town Council on Wednesday was asked to confirm resolutions of the Electric Light Committee, accepting the tender of W. H. Bailey & Co., Limited, for eight jet condensers, and pumps with steam exhaust, and water pipe work, at the Strawberry Road Electricity Works, for £16,500; and the tender of Mr. Bertram Thomas, for erecting at the new electricity works, six electrically-driven feed pumps, complete with connections to the tanks and boilers, for £3,157.

Swansea.—The Council has contracted with Messrs. Callender's Company for cables, conduits, &c., at £13,332.

Torquay.—The Council has given an order to the British Insulated Wire Company for electric light extension cables.

Wrexham.—The Town Council has accepted the tender of Mr. William Lord (Bury) at £825 for a Lancashire boiler in connection with the electric lighting works; and one at £1,550 from Messrs. Meldrum Bros. for a refuse destructor.

FORTHCOMING EVENTS.

Friday, April 6th.—At 9 p.m. Royal Institution. "Solid Hydrogen," by Prof. Dewar, F.R.S.

At 2 30 p.m.—The Institution of Civil Engineers. Students' visit to the works of the India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited, at Silvertown.

Saturday, April 7th.—Royal Institution. Lord Rayleigh on "Polarised Light" (Lecture V.).

Tuesday, April 10th.—At 8 p.m. The Institution of Civil Engineers. Ordinary meeting. Papers on "The Development of the manufacture and use of rails in Great Britain," by Sir Lowthian Bell, F.R.S.; and "The Wear of Steel Rails in Tunnels," by Thomas Andrews, F.R.S.

Monday, April 23rd.—At 8 o'clock. Institution of Civil Engineers. The eighth "James Forrest" lecture, by Sir William Preece, K.C.B., on "The Application of Electricity to Engineering."

NOTES.

Notice.—As next Friday is Good Friday, the ELECTRICAL REVIEW will be published one day earlier than usual. Will correspondents, advertisers, and all whom it may concern kindly bear this in mind?

Current Specifications.—A correspondent writes as follows:—"I am very glad to see you are mentioning, under the heading of 'Current Specifications,' the hard conditions invariably laid down for contractors for electric lighting materials. It is quite time some of the ridiculous specications sent out were revised, as they contain, generally speaking, obviously unfair and impossible conditions. One point is that of 'quantities' required. In order to make out a proper estimate, a contractor should know approximately what quantity he might be asked to supply, otherwise how can he possibly cover himself with the necessary raw material? It is the easiest thing in the world to insert a column setting forth the quantities of each article used under the previous contract, yet it is seldom, if ever done, and when the information is specially asked for, 'red tapeism' steps in and you are told your request cannot be complied with. Other contracts contain a clause to the effect that the cost of the contract stamps must be borne by the contractor, so that if your tender is accepted, you must pay a couple of pounds for stamps, whether you get any orders or not. This latter remark may seem absurd, but I have known and been notified that my tender had been accepted without, however, ever having received a single order, and maybe other contractors have had a similar experience. Tenders often state, 'The authorities do not bind themselves to the quantities mentioned or *any* quantities,' so that it is quite likely you may not receive a single order after you have paid the fees for contract stamps. Some antiquated Vestries ask for deposit of a 'bank-note' when applying for tender form. This probably dates back to the days when cheques were unknown, yet you see the same condition in the specifications of to-day, which only goes to prove the necessity of revising them and bringing them up to date. It is high time these 'one-man' contracts were abolished. The specifications should be drawn out by practical business men, then we should get reasonable conditions, but as matters now stand all the risk is on the side of the contractor."

Electrical Transmission in England.—The following notes recently appeared in the New York *Electrical World and Engineer*. They are comments which municipal electrical engineers ought to place in the hands of any of their committeemen who may be opposed to all electrical progress unless it be municipal:—

Some very interesting and promising schemes have lately been put forward in England for long distance transmission of electrical energy in bulk, on a plan that has long since become familiar in this country as well as in some parts of Continental Europe. For the life of us we cannot see what the objections are to such work in England, where cheap power must become more and more a matter of national existence; but as our London correspondent has lately detailed, a most virulent opposition is being exercised against the project from various municipal authorities who see in it the undermining of their power, prestige, and perquisites. If England allows this kind of thwarting to stand in the way of her progress, she will not merely have to take sound thrashings from the Boers until she overmasters them, but she will have to take worse punishment from more powerful foes. England's voluntary decadence would be a disaster to the world, just as her victories are those of equality and progress, and it is for her to make the right choice in just such emergencies as this. It should be understood that these English transmission companies ask no monopoly. All that they seek is the permission to sell current cheaply to any customer they can reach, regardless of his previous condition of servitude to a petty municipal plant; but they are apparently to be denied this opportunity to cheapen English goods in the markets of the world. If England doesn't care, we don't. It is a good thing for us to have these Little Englanders ruling the roost.

We have often expressed sentiments entirely in accord with what our American contemporary says, and we wish that the Little Englander of our municipal life could be brought to see the error of his ways. Perhaps the above remarks emanating from a keen and powerful foreign trade rival, as America has lately become, will have a little weight with those who are amenable to reason.

Alternating—or Intermittent?—*Scene*—The Law Courts. *Subject*—An electrical contract in a district supplied by a well-known London company.

COUNSEL CROSS-EXAMINING: Is it an intermittent current that is supplied to your premises?

NON-TECHNICAL WITNESS: I don't know much about it, but *it has been intermittent several times lately!*

USHER: Silence in the Court!!

The Postmaster-General.—The Duke of Norfolk having relinquished the Postmaster-Generalship because of his temporary absence in South Africa, Her Majesty the Queen has appointed Lord Londonderry to be his successor.

Who Knows?—"Solenoid" writes:—"Can you give me any information as to when the British Westinghouse Company are likely to commence manufacturing in their works at Manchester?"

[Early in the next century, we believe.—EDS. ELEC. REV.]

"A Critic's Error" Acknowledged.—There is published in London a journal calling itself the *Municipal Journal*. We think we had better remind our readers, lest they should forget. When we discover an error a little more glaring than usual, we don't think it becoming of our brother editor to take offence if we gently point it out, as we did when our contemporary gloried in the troubles of the City of London Electric Lighting Company, and said that it sold a unit for the same price as the cheapest hot-cross bun, instead of for the price of about five good ones. Of course our friends ascribe the error to the printer; who could expect otherwise? We have ourselves given up blaming the poor printer—in print at any rate—but we cannot help letting our readers see what a graceful (*sic*) correction our esteemed contemporary is pleased to insert (poked away in a corner as though it were ashamed of itself), minimising its critic's error:—

> The Electrical Review was greatly pleased with itself last week. It discovered a printer's error in our notes on the City of London Electric Lighting Company's accounts. The number of units sold by the company last year was 7,446,703, but an additional 4 had slipped in, which led the Electrical Review to "gather" that the company was selling two units for a penny. As the average price per unit was stated, the error was obvious, but we are glad to afford our contemporary an opportunity for trying to brighten up its dull columns. If the error had not been obvious to everyone the Review would not have seen it.

The effect of that "printer's" 4 was to add many millions of units to the City Company's output. Is this the way the *Municipal Journal* "brightens up its dull columns?"

Are Strikers Entitled to Poor Relief?—An Important Judgment.—In the present condition of trade, and by reason of the extraordinary interest taken by all classes of the community in the drama which is being enacted in South Africa, we are likely to overlook the importance of events which would attract notice and excite criticism in the days of strikes or the piping times of peace. To such a fate the recent decision of the Court of Appeal in the case of the Attorney-General *v.* the Guardians of the Merthyr Tydfil Union has apparently been consigned by the daily papers, and yet, were we involved in one of those labour disputes which, in recent years, have so frequently hampered our commerce and paralysed many industries, its importance would have even attracted the notice of the yellow press. About this time last year the friends of trade unionism were rejoicing in the decision of Lord (then Mr. Justice) Romer when this case came before him in the first instance. He had decided, in effect, that the Guardians of the Merthyr Tydfil Union were lawfully entitled to provide money out of the rates for the relief of strikers for whom there was plenty of work at hand if they only chose to accept it. True, his Lordship found that the cases in which the Guardians had granted relief were "of urgent necessity," and that if the defendants had asked for a declaration in terms less wide, he might have been able to grant them some relief against the rate. It remained, however, for the Court of Appeal to lay down the principle that it is illegal for Guardians to provide money to support strikers. Bearing in mind that this decision was arrived at by all three members of the Court of Appeal after an argument which lasted for a week, and that the judgment of the Master of the Rolls embodies a complete *résumé* of the law relating to the question before the Court, we may take it that the principle laid down will be affirmed, should it ever come before a higher tribunal. As we have said, the exceptional activity which prevails in all trades likely to be affected by strikes, may cause the masters and workmen to overlook the importance of this decision. And perhaps it may not turn out to be so important as it appears to be at first sight, for nothing prevents the Guardians from granting relief to wives and children during the strike. Nevertheless, when we add this weapon to the many others which in recent years have come to the assistance of capital in its struggle with labour, it is clear that the hand of the master is rendered appreciably stronger.

Personal.—Mr. V. J. Delebecque, A.M.I.E.E., has accepted a position with the British Electric Works Company, Limited, having resigned his position of manager to the Penistone Electrical Company.

Appointments Vacant.—The Birkenhead Tramways Committee wants an assistant electrical engineer at £3 10s. per week, and the Cardiff Corporation requires a mains superintendent at £150 per annum. See "Official Notices" to-day.

A clerk of works is wanted for the Hereford County and City Lunatic Asylum to supervise electric lighting installation and other work. A mains superintendent, at £120 per annum, is wanted by the Cambridge Electric Supply Company. See "Official Notices" to-day.

Lectures.—On Thursday last week Mr. Thomas Parker, J.P., delivered a lecture to the members of the Wolverhampton Y.M.C.A. on "What we Know and What we Don't Know." He dealt in an interesting manner with a great many branches of applied and theoretical knowledge, chiefly scientific, from the *pros* and *cons* of the metric system, to mathematics, electricity, engineering, chemistry, physics, &c.

At the St. Andrew's Institute of Engineers, Hull, last week, a paper was read by Mr. Muse on "Electrical Transmission of Power."

Mr. G. R. Peers has delivered two lectures on "Electricity" at the Public Hall, Wrexham.

B.A., 1901.—It is stated that Prof. A. W. Rucker has been nominated for the presidency of next year's meeting of the British Association which is to be held at Glasgow.

The Transport of Certain Metals during the Electrolysis of Distilled Water, by Dr. D. Tommasi.—The following is a brief *résumé* of the results obtained:—(1) Into a **U**-shaped tube filled with distilled water were plunged two platinum electrodes connected to the poles of two Daniell elements. The electrodes were about 10 millimetres apart. No visible effect was produced even after some time had elapsed. The calories given off by the battery were, however, more than sufficient to effect the decomposition of the water, amounting, in fact, to 98 cal.* (2) If, in the above experiment, a silver wire is substituted for the positive electrode, the following results are observed:—At the end of 18 hours no appreciable change is observed in the liquid; however, if after the silver wire has been taken out a drop of hydrochloric acid is put into the same branch of the tube, we observe a whitish appearance in the water having all the characteristics of chloride of silver. The hydrochloric acid has simply precipitated the slight quantity of oxide of silver that was in the distilled water. (3) With three Daniell elements the effect is much more noticeable. At the end of 15 minutes we can observe, by the aid of hydrochloric acid, that the silver is beginning to dissolve. After 18 hours we find the whole of the curved part of the tube coated with crystals consisting of a mixture of silver oxide and metallic silver. (4) If in the experiment just described we substitute for the three Daniell elements six Bunsen elements, the metallic deposit found at the bottom of the tube is considerable in proportion. (5) Copper also forms a crystalline deposit when it is used as anode in the electrolysis, or more probably the pseudo-electrolysis† of distilled water. The experiment is performed in the manner already described, *i.e.*, in the branches of a **U**-shaped tube, filled with distilled water, are placed a platinum wire and a copper wire, the first connected to the negative pole, and the second to the positive pole of a battery consisting of three Daniell elements. The distance between the two electrodes is about 40 millimetres. At the end of 18 hours we find on the lower part of the tube a layer of crystallised copper adhering to the sides of the tube. We also observe a deposit of copper on the platinum wire. (6) Gold used as anode does not produce any metallic deposit even under the action of eight Bunsen elements.

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* 98 cal. = heat given off by the two Daniell elements. 69 cal. = heat of decomposition of water. (For further details, *see* "Traité des Piles Electriques," by Dr. D. Tommasi, p. 60.)

† According to Dr. Tommasi, in the decomposition of distilled water by the electric current, two phases may be distinguished; in the first it is the dissociated elements that are carried towards the two electrodes (pseudo-electrolysis), and in the second it is the products of the decomposition of the water that are liberated (electrolysis). For further details see "Traité de l'Electrochimie," p. 31.

Still Motors.—The Still Motor Company, of Toronto, Canada, will exhibit through Messrs. Shippey Brothers, their London agents, some new types of electric motor cars, which will be on view at the forthcoming International Exhibition which opens at the Agricultural Hall on the 14th inst. All of the cars will be equipped with the new "Ideal Storage Batteries," for which a company is forming to purchase the British patents and build these Canadian electric motor cars in England.

NEW COMPANY REGISTERED.

McNamara (Birmingham) Limited (65,522).—This company was registered on March 30th, with a capital of £10,000 in £1 shares (5,000 preference), to acquire and take over as a going concern the business now carried on at the Rea Works, Balsall Heath Road, Birmingham, by Matthew J. McNamara, as "McNamara and Co.," and to carry on the business of founders, gas, steam and water fittings manufacturers, tube makers, electrical and mechanical engineers, makers of chandeliers, gasoliers and electroliers, &c. The first subscribers (each with one preference share) are:—Frank Davies, 121, Fordwich Road, Brondesbury, N.W., chartered accountant; Joseph Breeden Fair View, Lydiate Ash, near Bromsgrove, brass founder; Matthew J. McNamara, Rea Works, Balsall Heath, Birmingham, brass founder; Francis Breeden, Wake Green Road, Moseley, Birmingham, brass founder; Joseph B. McNamara, Park Road, Moseley, Birmingham, brass founder; Harry Meredith, Prudential Buildings, Corporation Street, Birmingham, chartered accountant; and William Turner, 22, Kingswood Road, Moseley, near Birmingham, accountant. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, £100; remuneration, £320 per annum, divisible.

CENTRAL STATION ACCOUNTS.

Bury Corporation Electricity Accounts.

The accounts of the electricity supply undertaking of the borough of Bury show gradual growth and improvement, and if the upward tendency continues, as there is every reason to hope, the corner should soon be turned, and the business pay its way. The capital expenditure is very moderate, but has increased by £7,500 during 1898. The load in kilowatts has risen by over 50 per cent. In 1897 there were four public lamps; a year later the number had increased to 18.

General Statement.

	1897.	1898.	Increase.
Total capital expenditure ...	£25,512	£33,079	£7,567
Number of units sold ...	64,462	115,853	51,391
Maximum load in kilowatts...	91	144	53
Gross revenue	£1,318	£2,183	£865
Gross profit	£539	£1,071	£532
Average price per unit sold...	4·76d.	4·35d.	−·41d.

The revenue account shows some interesting figures. In 1897 the gross revenue was only £1,320, and the total costs being £780, a gross profit of £540 was left to pay interest and sinking fund charges amounting to £1,120, the result being a net loss of £580. In that year the average receipts for current per unit was just over 4¾d., and just over 4 9/10d. per unit from all sources of revenue. In 1898 the gross revenue had increased by over £860 to £2,180, but the increase in total costs only amounted to £330, or a total of £1,110, thus leaving a gross profit of no less than £865 to pay interest and sinking fund charges (enhanced by £290), amounting to £1,410 nearly; the result being a net loss of £336; this being, however, a fall in net loss of as much as £243, a result upon which Mr. Watson, the engineer, is to be heartily congratulated.

Revenue Statement.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Sale of current	£1,277	4·76d.	£2,102	4·35d.	−·41d.
Meter rents	41	·15d.	81	·17d.	+·02d.
Supply of lamps, &c. ..	...	...	...	...	...
Sundry fees, &c.	...	...	...	...	...
Gross revenue ...	£1,318	4·91d.	£2,183	4·52d.	−·39d.

For a diminutive output the costs are extremely good, even for the provinces. Mr. Watson must be able to purchase cheap coal and obtain cheap labour, and make the most of these advantages to turn out 115,000 units with a coal bill of a little over £4 4s. per week, sundry engine room stores, at about £1 per week, and all salaries and wages together amounting to just £10 per week. All items show reductions, save only "establishment charges," but "works' costs" are down to less than 1¼d., and "total costs" to just below 2½d., being improvements on 1897 figures by, roughly, ¼d. and ⅜d. respectively.

Cost of Production.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Coal	£132	·49d.	£225	·47d.	−·02d.
Oil, waste, water, and engine room stores.	53	·20d.	51	·10d.	−·10d.
Salaries and wages incurred in generation and distribution.	207	·77d.	243	·50d.	−·27d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	38	14d.	48	·10d.	−·04d.
Works' costs	£430	1·60d.	£567	1·17d.	−·43d.
Rent, rates, and taxes ..	150	·56d.	209	·43d.	−·13d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	176	·65d.	279	·58d.	−·07d.
General establishment charges, stationery and printing, law charges and insurance.	23	·09d.	57	·12d.	+·03d.
Other expenses	...	...	...	...	...
Total costs ...	£779	2·90d.	£1,112	2·30d.	−·60d.

We have already dealt with the appropriation of profits when considering the revenue statement. It may, however, be again mentioned that so favourable results both from the engineering and financial standpoints from so small a station reflects credit upon all concerned.

Profit Statement.

	1897.	1898.
Interest on loans	£570	£776
Sinking fund for repayments	548	631
Net profit carried to rates*	−579	−336
Gross profit	£539	£1,071

* Deficit charged to general rate.

CITY NOTES.

National Electric Free Wiring Company.

The annual meeting of this company was held on Monday at Faraday House, W.C., Mr. R. S. Bain presiding.

In moving the adoption of the report, which appeared in our last issue, the Chairman said he was glad that, as he had hoped at the meeting a year ago, they were now able to declare a dividend. It was not a large one, but it was a beginning, and the promise of larger dividends in the future. They might congratulate themselves that it had been earned in the second year of the company's existence—a company of an entirely new departure. The business had shown a steady rate of increase during the year. They completed 1,970 installations, of the equivalent of 51,774 8 c.p. lamps, being an increase of 994 installations with 27,276 lamps over the previous 15 months. Of those, 838 installations with 24,654 8-c.p. lamps were free wired, and 1,132 installations with 27,120 8-c.p. lamps were for contract work. They had in hand at the end of the year orders for 395 installations with an aggregate of 13,012 8-c.p. lamps, and since the books were closed they had received orders for 478 installations with 13,021 8-c.p. lamps, which was more than double the number they had in hand when they started last year. Those new orders were very nearly equally divided between free wiring and contract. It would probably make it clearer to show the progress they were making if he said that the orders they had taken for the first three months of the present year more than exceeded those taken for the first six months of last year. They entered during the year into free wiring contracts with a number of corporations and supply companies whose names are mentioned in the report. The majority of the free wiring contracts were of a profitable nature, and had proved very useful as feeders for their contract work. Some of the older ones had not proved as profitable as they expected, and those they had terminated. In addition to the contracts actually concluded, others had been arranged, and in the case of three important districts they were only waiting to be sealed. It would be seen that they had no lack of work for the current year. One very important contract had been sealed during the last few days with Poplar, which promised to be a very profitable business indeed. They had two others which they thought would turn out equally well, and he was informed that they would be sealed at the next meetings of the Corporations. Turning to the accounts, the gross revenue was £5,648, as compared with £3,244 for the previous 15 months. Of that amount £1,440 was for free-wired installations, as against £735 for the previous year, or nearly double. It was to this item that they looked for a steady annual increase, and every installation they connected was a permanent source of revenue. They started the present year with 1,514 free-wired installations, all of which were revenue earning, as compared with 680 for the preceding year. The

revenue for the quarter ending December last was more than double that of the corresponding quarter of 1898. They had every reason to take that as a gauge of what the following quarters would be this year. The profit from contract work was £3,368, against £2,037 for the preceding 15 months, an increase of about 65 per cent. They had carried out some important contracts during the year, all of which had given satisfaction, and another satisfactory feature was the cost of the installing per 8 c.p. lamp. That kept within the figure given in the prospectus. The receipts from interest, discounts, commission, and sundries, amounted to £840, also showing a substantial increase. On the other side of the account the total expenses were £3,862, an increase of £1,840; that increase was principally in the first item, and was owing to the large number of new branches opened during the year. That increase might be looked upon as sowing seed from which they might ultimately reap a harvest. The board had again relinquished half their fees, and had further decided not to draw their full fees until they could pay 5 per cent. They had added to the board by appointing Mr. Bernheim, who, together with his friends, represented the largest holding of shares in the company. They had written off £245 for bad and doubtful debts, and £1,785 was the balance left, to which they added £1,222, brought forward, making a total of £3,008. Out of this they had made a provision to cover possible allowances on contracts in course of settlement £650, and had written £574 off for depreciation, £337 being on free-wired installations as against £121 last year. They had not strained the results to declare a dividend. The balance remaining was £1,782, out of which they recommended 3 per cent. dividend, and carried forward £281. The balance showed capital including 18,851 shares paid to vendors, as £69,911. Since the end of the year they had made a call of 2s. 6d. per share, which placed them in funds, for the present, to meet the increase in business following the opening of new branches. The total amount due to the company to creditors was £4,395, not a very large amount. On the other side, the value of free-wired installations was £21,108 as compared with £9,729, an increase of £11,552. The outlay on contracts in course of completion, £5,581, was slightly less than last year. The expenses of opening 15 new branches was £742. In each item they had provided for depreciation. The amount due to the company was more than £9,722. They were greatly indebted to their principal manager, their district managers, and staff generally, for the way they had done their work.

Mr. J. W. Swan seconded the adoption of the report, which was carried, and the retiring directors and auditors having been re-elected, the meeting closed with complimentary remarks from shareholders on the position of the company.

London Electric Supply Corporation.

The annual meeting of this corporation was held at Cannon Street Hotel on March 28th, Lord Wantage presiding.

In moving the adoption of the report and accounts, his Lordship introduced to the meeting Sir W. H. Preece, who had joined the board in the place of Mr. de Quincey, who resigned owing to his health. The report showed that the corporation had increased their lamp connection during the year by 18,587 lights, an increase of less than half the number they expected, and would have obtained—seeing that the increase had been obtained almost entirely during the first six months of the year—but for the unfortunate default on the part of the contractors in the delivery of the additional plant ordered to meet the last winter's requirements. At the last meeting he gave them particulars of the plant they had contracted for during the year 1899. The most important of those additions, so far as it affected their general supply, was the contract entered into with a high-class firm for six 400-h.p. boilers. That order was given in November, 1898, and delivery was guaranteed on May 31st, 1899, under a penalty of £30 per week for every week's delay. The boilers were not finally completed until the middle of November, six months after date. In the meantime the lamp connection had increased in accordance with their estimates, and the result was that they were unable to take out the existing boilers for the usual summer overhaul, and as the load increased with the approach of winter it was with great difficulty that they were able to fulfil their obligations in the way they did. It was not only in the case of the new boilers that they were disappointed, but in every other contract into which they entered for new work they had the same unfortunate experience. Their coal transporter, which was contracted to be delivered in October last was not completed until February. The contract for heightening the chimney and giving better draught was stopped by the London County Council, as the existing chimney would not carry the extra weight. The water-softening plant contracted for to be completed in the beginning of October was only completed in March this year. The explanation given by contractors was that during the last year the engineering and allied trades were so congested with orders that they were unable to get the necessary material to fulfil their contracts. Other companies had experienced similar difficulties. The penalties they were able to impose for the delays were altogether inadequate to compensate them for what they had suffered. Not one of the accidents of the year had been due to electrical causes, but they were due to the steam system almost entirely, and to the non-delivery of the boilers. Those difficulties were entirely beyond their control, and were such as might happen to any class of business, and had nothing to do with the system of supply. Turning to the accounts, the capital account showed that they had spent £52,735, while the addition to the loan capital was £9,870, being the deposit on the issue of 4 per cent. debenture stock, which was largely over-subscribed for. They had expended £24,065 on plant and machinery during the year. For that expenditure they had received a new 900-h.p. plant, which was completed in September last. They had partly paid for the new 400-h.p. boilers, and had paid the final instalment on the 2,000-h.p. plant, the final instalment on the condenser, and the first instalment on the water-softening plant, the new coal transporter, the new coal storage floor, the new well they were sinking, and the alterations in the furnaces to make them smoke consuming. The expenditure on mains was £12,599, for which they had laid 22,251 yards of new mains, trunk and distributing, bringing the total length now laid up to over 106 miles. Transformers, meters, electrical instruments, and tools, represented the amounts expended on those goods to meet the normal increase of business. Distributing stations and offices had cost £7,066, this representing the purchase of 58 years' lease of the offices and station in Cockspur Street, a most advantageous purchase to the company, considering the value of the surrounding property, the whole of which had been purchased by the London County Council. Had the London County Council secured this property, it would have been formed into one complete block, and the company would probably have had to vacate their station, and the amount they had expended on the station would have been lost. That arrangement was carried through by the tact and discretion and careful supervision of the managing director, and they had obtained a most advantageous bargain, as they would have had great difficulty in finding any other site in the neighbourhood suited to their requirements. The sum mentioned included the cost of remodelling, and new flooring to the offices. The total amount written off for depreciation and obsolete plant, £227,565, was a considerable sum, and was a good answer to the question as to what amount they had set aside as a reserve fund to meet depreciation. That depreciation ought to last for a considerable time. The gross revenue for the year was £72,901, and that for the year 1898 £67,099, an increase of £5,801 16s. 10d. The total expenditure increased, however, from £43,266 in 1898 to £51,354 in 1899, an increase of £8,088. That was entirely due to the cost of generation, the increase there being £8,006, leaving an increase of only £80 for the year in all other departments. That large increase was almost entirely made up of four items, viz., coal, water, wages, and repairs, and to a very large extent had been caused by the circumstances already explained, namely, the default of contractors in delivering the new boilers, this having reacted upon the whole steam system, owing to the existing plant being over-strained, and causing inefficiency and breakdowns. They had other difficulties to deal with, the increase in the coal bill being £4,223. They had experienced great difficulty in obtaining supplies of Welsh coal during the greater part of the winter, as the Government had requisitioned the whole supply of Welsh coal in connection with the war. The company had to purchase any class of coal they could get, a large proportion being an inferior class of North country coal, which being unsuitable for their boilers a great deal more of it was consumed. They had an increased water bill by £1,000, because they had to discontinue the use of their own wells owing to the action of that water in their boiler tubes, and to use the supply of the Kent Water Company. The increase in wages was £1,000, and in repairs and maintenance £1,500, the latter being almost entirely confined to engines and boilers, and directly attributable to the causes already explained. The total of all the other departments only showed an increase of about £80, and only represented ¾d. per unit sold, which showed that their company was one of the most economically managed in the kingdom. The balance carried to net revenue was £21,547 odd, which with the amount brought forward and the amount received as interest, brought the total to the credit of that account to £25,412. Out of this was paid interest on debentures to December 31st, £8,000, and as they had earned the interest on their preference shares for the half-year ending June, they paid that by way of interim dividend, that amounting to £7,476. There was thus £9,936 now to be dealt with, as explained in the report. By setting apart £1,000 for rebates they hoped to allow those of their consumers who had been affected by the interruptions a special discount off their accounts, and they hoped that would go a long way to satisfy them. They proposed to carry forward £1,460 which was less than for the previous year, but considering the difficulties they had had to contend with during the last three months of the year, he would not have been surprised if they had been compelled to reduce the dividend. He was glad that it had not been necessary to do that. The result had been obtained owing to the unremitting care and energy of the staff and officials, Mr. Bain and those who had so carefully worked under him. As to what they proposed to do in the way of additions and improvements in the current year, it was their intention to improve the whole of the machinery and the general working of the station during the summer so as to ensure that the supply during next winter should be thoroughly efficient and reliable. They had ordered two new engines of 450 h.p. each from Messrs. Allen & Sons, of Bedford, by means of which they hoped to run the works from night to sunrise, which would enable them to shut down the large plant during that period. The engines were to be delivered in June. They were putting down a battery of six new 400 h.p. boilers of the "Economic" type. They were guaranteed for delivery in May, and in view of the delay in the previous six, they had communicated with the makers, who declared that delivery should be given at the very moment of contract time. In addition to those new boilers they had entered into a contract with Babcock & Wilcox to rebuild 12 of the old boilers to make them practically as good as new. The improvements in the steam system did not end there. The consulting engineer had designed a complete new system of steam pipes to replace the existing system, which had been found inefficient and extravagant. That would enable them to shut down the station if they required to do so—which they could not do at present. As the London County Council prevented the company heightening their chimney, they had placed a contract for a new chimney 240 feet high, which would give them the whole draught they required for all their boilers and allow for extension, and help them to a considerable extent to get rid of the smoke nuisance. Their water bill was very great, and they were

sinking a large well at Deptford, from which they hoped to receive the whole of their supply. It would be 450 feet deep. They had originally two tubular wells at the station, which considerably reduced the water bill, but surface water seemed to have made its way into the wells, this water carrying with it chemicals which had a very deleterious effect upon the boiler tubes. They were sinking a well nearly three times the depth and capacity of the tubular wells. In addition to these works they were reconstructing some of the large engines, which would considerably increase their capacity and efficiency. All of these works were in connection with the steam system. A new exciter of 75 H.P. was the only increase in the electrical system. They had sufficient capital to carry them on until the autumn, by which time it might be necessary to make a further issue, and they were to be asked to pass a resolution in regard to that matter. The meaning of the resolution was that while the directors had the power under their arrangements with debenture stockholders to borrow up to the extent of half of the nominal share capital of the corporation, under the articles the borrowing power was placed at £250,000, and that could not be exceeded without the sanction of a general meeting. That limit having been reached, the resolution was to ask that the board should be at liberty to borrow such further sums as they deemed necessary in the the interests of the company, so long as the amount of the loan capital did not exceed £250,000. During the year under review the company was served with a writ for the infringement of a patent in connection with its transformers. As the matter affected every alternating current station in the kingdom, the company took immediate steps to defend the action. Every alternating station in the country was communicated with and forces were combined for joint defence, a committee representing about 60 lighting authorities being formed, with Mr. Bain as chairman. That committee acted for the defence. The result of the action was a verdict in the company's favour, carrying costs on the higher scale. The actual amount each company had to pay was not great, considering the interests at stake. There had been an appeal against that decision, which would also have to be fought. A year ago the future looked bright. They had emerged from a position which few companies being ever survived. Had the exceptional circumstances not occurred, a dividend on the ordinary shares would been earned during the year. They were not the only company which had suffered troubles during the past winter. The delay was only a temporary one. The use of electricity was growing by leaps and bounds. They had only touched the fringe of the great demands which would be made on electricity in the large area comprising some 14 parishes in which they had powers. They had yet to reach the great middle-class population, who would form their principal customers. As the holder of nearly two-fifths of the capital, he personally had confidence in the company.

The adoption of the report was seconded by Sir W. H. Preece, and after a few hypercritical comments, some of a more or less personal nature, from Mr. Pyke, who urged the chairman to surround himself with business men, and not to let the company be a one-man company, the resolution was carried unanimously.

The retiring director, Earl Crawford, and the auditors having been re-elected, the resolution *re* borrowing powers, was carried, and the proceedings closed.

Bright's Light and Power Company.

At the adjourned second ordinary general meeting of the company, held at 14, Copthall Avenue, E.C., on 20th ult.,

The Chairman said that the annual general meeting was called for December 12th, and was adjourned in order that the managing director, Mr. Bright, who was returning from South America, might be present, and that the audited accounts might be presented. The position of the company's business was extremely satisfactory, and they might have divided a much larger dividend. They preferred to recommend the dividend of 9 per cent. for the period extending from July 1st, 1898, to December 31st, 1899, and to carry forward the sum of £3,203 3s. 1d., that being practically the whole of the profits earned by the Salta portion of the business, which did not come under the control of the board until December 31st, 1898, Mr. Bright, the vendor, agreeing to pay in £1,000 in lieu of profits from July 1st, 1898, to the end of December in that year. Considerable delay occurred in the delivery by the contractors of the machinery and plant for the Salta Works; that had now been delivered, and they hoped would soon be erected and in full work. They had a large number of consumers waiting for the electric light, and had no doubt that the Salta portion of the business would prove exceedingly remunerative in the near future. At Santiago the demand for the electric light was still on the increase, and the business was in a very satisfactory state; the expenses were kept down as low as possible, and the profits had been most satisfactory, notwithstanding the largely increased price of fuel and the non-employment of the power plant of the grinding mills, which had been closed during the greater portion of the time in consequence of the slackness of trade in the local tanneries, which cut off the demand for their tannery products. The depression in the tannery trade occurred periodically every few years, and as soon as that trade revived it would bring a considerable accession of profits. In the balance-sheet was an item of "calls in arrear," amounting to £12,653 10s.; this sum, which formed a portion of the amount still due to the vendor on account of the purchase money, was not required until the machinery at Salta had been delivered; the directors, therefore, informed the shareholders that the call need not be paid until they had further notice. They now proposed to collect the amount, and make a payment to the vendor. The debenture capital also was not required, and the debentures which were subscribed for had been paid off. The report and accounts were passed.

Willans & Robinson, Limited.

The half-yearly report to be submitted at the meeting to be held at Cannon Street Hotel, London, on Wednesday, April 11th, reads as follows:—

The accounts for the half-year ended December 31st, 1899, are submitted herewith. After writing off as depreciation from plant, patents, &c., the sum of £5,658 15s. 10d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £4,944 2s. 6d. brought forward) is £32,140 13s. 6d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and 10 per cent. per annum upon the ordinary shares, together amounting to £13,324 14s. 5d., and that a bonus of 2 per cent. be paid upon the ordinary shares for the year 1899, amounting to £3,193 6s. 10d. The amount payable to the original directors, in accordance with the articles of association, is £4,911 1s. 2d., leaving a balance of £10,712 1s. 1d. From this the directors propose to carry £2,000 to the debenture redemption fund (now invested in the names of the trustees for the debenture holders), and £8,500 to the reserve fund, leaving a balance of £5,212 1s. 1d. to be carried forward. The directors propose shortly to invite applications from the shareholders for 10,000 preference and 10,000 ordinary shares, remaining to be issued under the authority of the extraordinary resolution passed upon March 29th, 1899. Mr. Mark Robinson and Lieut.-General Sir Richard H. Sankey, K.C.B., R.E., retire from the board, in accordance with the provisions of the articles of association, but are eligible, and offer themselves for re-election. The auditors, Messrs. Cooper Bros. & Co., also retire, but are eligible for re-election.

Brockie-Pell Arc Lamp, Limited.

The third annual report of the directors to be presented at the meeting to be held at the company's new premises, 60, Worship Street, Finsbury, E.C., on Monday, April 9th, at 3 p.m., reads as follows:—

In submitting the accompanying profit and loss account and balance-sheet for the 12 months ending December 31st, 1899, the directors have pleasure in calling attention to its being much more satisfactory than that of the previous 12 months, showing the continued progress in the company's business, and a further improvement in its profits and management. The profit and loss account for the year, before charging depreciation, shows a credit balance of £1 287 13s. 7d., as against a debit balance of £1,496 15s. 5d. for the preceding 12 months, which the directors have applied as under:—

	£	s.	d.
To depreciation of 5 per cent. for two years (no amount having been written off such account last year) on plant and machinery	408	9	10
On furniture and fixtures do. do.	92	11	8
„ Tools	166	17	5
„ Patterns	135	11	9

making a total of £798 10s. 8d. thus written off, and leaving a balance of £489 8s. 4d., which the directors propose to carry forward. The serious and continued increase in the price of metals has affected the company's profits. The sales of the company's lamps continue to show an increase over those of the preceding year. The company have during the past year supplied their patent lamps to the Corporations of South Shields, Ayr, Greenock, and Stirling, also to Her Majesty's Government, and the London and North-Western Railway, and are now supplying them to the city of Gloucester and the Vestries of Lambeth and Poplar. The directors are increasingly convinced with the great advantage that has accrued to the company from the appointment of Mr. Shrimpton as managing director, and consider it is largely due to his ability and devotion to its service, upon a very inadequate remuneration, that the company is in such a different position to that it formerly occupied. The plant and machinery have been maintained in thorough efficiency, and additions have been made during the past year. The serious inadequacy of the company's present works referred to in their last report, has led the directors, after most careful consideration, to secure, on advantageous terms, the larger and more suitable premises at 60, Worship Street, Finsbury, E.C. Such new premises, with the increased facilities they offer, will enable the directors not only to meet the present increasing demand for the company's patent lamps, and to keep the necessary stock, but also to cope with a still larger business they are confidently looking for in the near future. Under the articles of association the Hon. R. Brougham is the retiring director, but being eligible, offers himself for re-election. The auditors, Messrs. Mellors, Basden & Co., also offer themselves for re-election.

The Folkestone Electricity Supply Company, Limited.

The directors' report, presented to the fourth ordinary general meeting, held at the company's works, near Shorncliffe station, Folkestone, on Saturday last, March 31st, reads as follows:—

Your directors submit herewith a statement of the accounts and balance sheet made up to December 31st last. Your directors have pleasure in reporting that the prospects of the company are very satisfactory. Up to December 31st, 1898, the equivalent of 10,089 8-C.P. lamps were being supplied, whilst up to December 31st, 1899, 17,884 8-C.P. lamps were being supplied, being an increase of 77 per cent. during the last 12 months. It will be seen from the accounts that there is a profit on the revenue account, after charging the sum of £220 1s. 9d. for preliminary expenses against the year's accounts, of £2,084 0s. 11d., which with the sum of £405 2s 3d. brought forward from last year's accounts, and after paying bank charges on temporary overdraft, show a net balance for distribution of £2,442 8s. 8d. Out of this your directors recommend the payment of a dividend at the rate of 4 per cent. per annum, which will absorb about £1,900, the placing of £400 to a reserve fund, and the balance to be carried forward to next years' accounts. During the past year, the company has carried out installation work for consumers, to the value of £2,709 16s. 6d., the profit only on which, viz., £90 1s. 6d. has been brought into the year's accounts. From the statement at the foot of the accounts, it will be seen that the number of units sold to private consumers during the past year is 209,981, whilst the revenue received from the same source is £4,156 8s. 5d., thus the average cost per unit to the consumer, works out at about 4¼d. Under the company's regulations two of the directors, Messrs. S. Penfold and C. J. Pursey retire by rotation, but they are both eligible, and offer themselves for re-election. The auditor, Mr. Richard White, also retires, but is eligible and offers himself for re-election.

Babcock & Wilcox, Limited.—The directors' report for 1899, to be submitted to the meeting to be held in London on 10th inst., states that the profit amounts to £106,585, and with £9,333 brought forward is increased to £115,919. Interim dividends for the

half-year to June 30th, 1899, at the rate of 6 per cent. per annum on the preference shares and 20s. per share on the ordinary shares, amounting to £25,000, have been paid, leaving £90,919. The directors recommend a dividend at the rate of 6 per cent. per annum on the preference shares, £3,000, and a dividend of 20s. per share on the ordinary shares, £22,000, placing to the reserve fund £50,000, and leaving to be carried forward £15,919.

Stock Exchange Notices.—The Stock Exchange Committee have appointed special settling days as under:—Tuesday, April 10th.—Buenos Ayres and Belgrano Electric Tramways Company, Limited—fully and partly paid provisional certificates for £120,000 5 per cent. second debenture stock, and ordered same to be quoted in the Official List; W. T. Henley's Telegraph Works Company, Limited, further issue of 18,000 4½ per cent. preference shares of £5 each, fully paid, Nos. 12,001 to 30,000 are also to be officially quoted.

City of London Electric Lighting Company.—An extraordinary general meeting of this company was held last Friday at Winchester House, Sir David Salomons presiding. The resolution passed at the general meeting on March 15th, approving the City of London Company's Bill to "empower the company to acquire lands and work generating stations and for other purposes," was confirmed as a special resolution, after the chairman had given an outline of the powers sought.

Prospectus.—The Potteries Electric Traction Company, Limited, announce an issue of £125,000 4½ per cent. debenture stock at the price of 103. The stock is redeemable at £108 per cent. It is offered for subscription on behalf of the Potteries Company by the Electric and General Investment Company, Limited. The company has a paid-up share capital of £400,000 in 5 per cent. preference and ordinary £10 shares, and its objects are well known to our readers.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31st, 1900, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income-tax, payable on May 1st to the stockholders registered on the books of the company on March 31st, 1900.

Oriental Telephone and Electric Company, Limited.—The directors have resolved to recommend, subject to final audit of the accounts, a further dividend of 8d. per share, free of income-tax, making together with the interim dividend paid in October last, 5 per cent. for the year ended December 31st, 1899.

Eastern Telegraph Company.—The directors announce dividends at the rate of 3½ per cent. per annum on the preference stock for the quarter ending 31st ult., and an interim dividend of 1½ per cent. on the ordinary stock in respect of profits for the quarter ended December 31st, 1899.

British Westinghouse Electric Company.—The directors have declared an interim dividend, calculated to January 31st on the preference shares in respect of £3 per share paid thereon at that date.

Anglo-Argentine Tramways Company.—The report of the directors says that they have secured an electrical concession for 99 years from the municipality of Buenos Ayres.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending March 31st, 1900, were £200 10s. 6d.; receipts for corresponding period, 1899 (1899 week includes Good Friday), £433 0s. 4d.; aggregate for half-year to date, £2,073 12s. 5d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 30th, 1900, were £2,552 3s. 5d.; corresponding period, 1899, £2,745 18s. 9d.; decrease, £193 15s. 4d.

The City and South London Railway Company.—The receipts for the week ending April 1st, 1900, were £1,360; ditto April 2nd, 1899, £889; increase, £471. Total receipts for half-year, 1900, to date, £15,939; corresponding period, 1899, £14,239; increase £1,700. Miles open April 1st, 1900, 3½; April 2nd, 1899, 2½.

The Dover Corporation Tramways.—The receipts for the week ending March 31st, 1900, were £145 4s. 9d.; April 1st, 1899, £199 6s. 2d.; decrease, £54 1s. 5d. Total receipts to date, 1900, £1,868 18s. 10½d.; corresponding period, 1899, £1,895 19s. 0d.; decrease, £27 0s. 1½d. Miles of track open, 1900, 8; 1899, 8. Car miles run, 1900, 4,942; 1899, 4,405. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, March 30th, 1900, were as follows:—D. U. T. Co., horse cars, £48 7s. 8d.: ditto, electric cars, £2,886 13s. 4d.; D. S. D. Co., electric cars, £653 11s. 3d.; total, £3,588 12s. 3d.; corresponding week last year—D. U. T. Co., horse cars, £1,714 11s. 8d.; ditto, electric cars, £969 15s. 1d.; D. S. D. Co., electric cars, £661 2s. 9d.; total, £3,345 9s. 6d.: increase, £243 2s. 9d. Aggregate to date, £44,866 17s. 7d.; aggregate to date last year, £41,088 7s. 0d.; increase to date, £3,778 10s. 7d. The mileage worked is 42 miles electrically, 2 miles by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending April 1st, 1900, were £588; week ending April 5th, 1899, £564; increase, £24. Total receipts to date, 1900, £30,204; ditto. 1899, £11,274. Number of cars, 1900, 28; 1899, 15. Miles of track open, 1900, 12; 1899, 64.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 1st, 1900, amounted to £1,277; corresponding week last year, £1,405; decrease, £128. Total increase in traffics for half-year to date, £1,112.

The South Staffordshire Tramways Company.—The receipts for the week ending March 30th, 1900, were £617 4s. 8d.; March 31st, 1899, £572 5s. 3d. Aggregate receipts for 13 weeks, £7,826 11s. 3d.; last year, £7,664 18s. 1d.

STOCKS AND SHARES.

Wednesday Evening.

The slow progress of affairs in South Africa is still acting as a dead weight upon business in the Stock Exchange. That there is an immense amount of money awaiting investment throughout the country has been abundantly shown by the avid way in which several of more popular public issues have been applied for lately. People, however, are still timid about entering the general markets, fearing lest a check to our troops at the front may bring with it a sharp fall in values, when they could buy at greater advantage than now. Moreover, the Money Market is so hard that cash can be lent to the banks on deposit at reasonable rates of interest, so that taking everything into consideration, it is not at all surprising that Stock Exchange markets remain inanimate. There can be no doubt that the return of peace will usher in a rush of business upon a scale of immense magnitude, and the cautious investor must not wait too long before buying, otherwise he may find himself in the unpleasant position of having "missed his market."

Quite a sensational rise has taken place in the Ordinary shares of Babcock & Wilcox since we last wrote. From 49 the price rapidly advanced to 59 upon reports that the shares are to be split into a smaller denomination, and that a reconstruction of the company is contemplated. At present the shares are of £10 each, and standing as they do between 58 and 60, the small investor naturally leaves them alone. It is urged that if these £10 shares were converted into £1 shares a very much freer market would be ensured, and that the public would eagerly buy them. The first part of the argument is certainly correct, but we doubt whether there would be any great demand for shares which at 50 only return 4 per cent. on the money, while at 60 the yield is a fraction over 3 per cent.

The City of London Electric Lighting Company is certainly plucky to make its new issue of Ordinary shares at so high a price as par, considering that the current lot stands no better in the market. The company appears to think that its friends will assist it in taking the new shares, and we hope, for the City of London's sake, that they will. A few dealings are taking place in the latest emission at ¼ discount to ¼ premium. The old shares are quoted at the same price, *ex* a dividend of 8s. per share, and *ex* the right to apply for the new.

Three of the principal companies' Ordinary shares in the supply list were quoted less the dividend on March 29th, Bromptons and County of Londons quickly recovering the deductions. The Preference shares have been equally strong, with the exception of London Electric Preference, which are 2s. down, allowing for the dividend. The feature in this department has been a smart rise of £1 per share in Westminsters, which have suddenly come into favour on influential buying. St. James's and Pall Mall are also better, and this is the company whose shares appear to have, at the moment, the best chance of a rise in the near future. As regards the price of several of the supply undertakings, it must be remembered that the new shares are now quoted together with the old, but the admission of these late comers has not had the weakening effect which is frequently to be observed in such cases.

We are able to announce that a new issue of 5 per cent. Debenture stock will shortly be made by the Edison & Swan United Company. Underwriting letters are now flying about, and the public announcement may be made any day. As a lock-up investment, the investor may find the stock merits consideration, but there is not likely to be much market made in it. The existing 4 per cent. Debenture stock of the company stands at 94.

In the electrical railway department Central London half-shares, both Preferred and Deferred, have undergone a relapse after the advances of last week. This is due to the weak condition of the railway market generally, and to the absence of further buyers, those of a week ago being readily supplied. Great Northern and City Preferred Ordinary "A" shares (£5 paid) are quoted 3 to 5, but dealing in them is quite a matter of negotiation. City and South London has successfully maintained its position at a shade below 70.

A drop of 3 per cent. in Eastern Ordinary forms the principal feature of the telegraph market. The 4 per cent. Debenture stock has also lost a point. Selling was induced by the less satisfactory character of the news from Lord Roberts on Monday and Tuesday. A large block of stock, on account of a deceased estate, has come on to the market, helping to depress the price, although the stock still carries the dividend of 1¼ per cent.

The Anglo-American stocks exhibit no change, and speculation in them has become quiet again. Western Telegraphs at 15, *ex* a dividend of 3s., are the same as they were before, and the remark also applies to Direct United States shares, which remain at 11⅜, *ex* the same amount.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation, March 28th.	Closing Quotation, April 4th.	Business done during week ended April 4th, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s	73/6	65 — 68	65 — 68	...	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	117 —118	117 —118	117¾	117
3,062,240	Do. do. Deferred...	Stock	...	18s. %	£1 7s	15 — 15½	15 — 15½	15½	15 3/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	...	...	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175 xd	...	...
1,332,823£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	103½	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	1 %	...	¼ — ¼	¼ — ¼	...	...
16,000	Cuba Telegraph	10	7 %	8 %	...	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	19 — 20	19 — 20	20	...
12,931	Direct Spanish Telegraph	5	4 %	...	...	4 — 5	4 — 5 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	10	...
80,000	Do. do. 4½ % Debs.	50	...	...	...	101—105%	101 —105%	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	11½— 12	11½— 12 xd	11⅝	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	155 —160	152 —157	155½	153
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	98 —101	98 —101	100⅜	99
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	116 —121	115 —120	118	116
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	16 — 16½	16 — 16½	16 7/16	16½
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	100 —103	100 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	115 —120	115 —120	116	115
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb., Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	...	...	...	101 —104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	5½ %	...	11½— 12	11½— 12	11 13/16	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15½— 16	15½— 16	16	15 13/16
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	...	...	32 — 34	32 — 34	33	...
96,800	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	54 — 58	54 — 58	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	105 —108	105 —108	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ¼	¼— ¼	...	...
86,492	Do. do. 5% Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	5 — 5¼	5 — 5¼	5 3/16	5 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	14½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5¼— 5½	5¼— 5½	5 7/16	5¼
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½%	97 —100	97 —100	98½	97
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	¾— 1	¾— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	102 —105	102 —105	...	...
11,839	Reuter's	8	5 %	...	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	126 —131	126 —131	...	...
58,000	United River Plate Telephone	5	5 %	6 %	6 %	4¾— 5¼	4¾— 5¼	...	...
16,639	Do. do. 5 % Cum. Pref. Nos. 1—16,639	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	%	...	...	97 —100	97 —100	...	...
80,008	West Coast of America, Nos. 1—80,000 and 53,001—53,008	2½	...	...	...	¾— 1	¾— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	100 —104	100 —104	...	...
205,993	Western Telegraph, Ltd., Nos. 1—205,993	10	...	...	...	14¾— 15½	14¾— 15½xd	15	14¾
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	108 —109	108 —109	...	...
88,321	West India and Panama Telegraph	10	...	...	...	¾— 1¼	¾— 1¼	...	...
34,568	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	9½— 9¾	9½— 9¾	9¾	9 11/16
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	7 — 8	7 — 8	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	104 —107	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	...	7 — 8	7 — 8 xd	7¾	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	...	...	8¼—9¼	8½— 9½	8 9/16	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9½— 10½	9½— 10½	10⅛	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	6 %	6 %	6 %	7 — 8	7 — 8	...	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	...	...	110 —112	108 —111	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	10 %	6 %	4 %	10 — 11	10 — 11	10½	9½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	13 — 14	12½— 13½	12⅝	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	122 —127	122 —127	127	125
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	4 %	9½— 10½	9½— 10½xd	10½	10
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12½— 13½	12½— 13½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	109 —112	109 — 112	...	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	5 %	7 %	...	4¾— 5¼	4¾— 5¼	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1¾— 2¼	1¾— 2¼	...	...
48,050	Do. do. do. 6 % Pref.	5	...	6 %	...	4¾— 5¼	4¾— 5 xd	...	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	14 — 15	14 — 15	14¾	14 7/16
280,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	...	...	114 —117	114 —117	...	...
126,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	96 — 98	97½	97½
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15½— 16½	15½— 16½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	14½ %	14½ %	14½ %	14 — 15	14½— 15½	14 15/16	14 9/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	9	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	...	2¼— 2¾	2⅜	...
50,000	Do. Do. 4 % Deb.	100	...	...	...	...	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	4 — 4½	4 — 4½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	12 %	12 %	13 %	13½— 14½	14½— 15½	15½	14 9/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Mar. 28th	Closing Quotation April 4th.	Business done week ended April 4th, 1900. Highest.	Lowest
65,000	Aluminium shares, Nos. 1—65,000	† 1	10 %			2⅜— 3½	2⅜— 3½	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	... ...			97 —102	96 —101 xd	...	...
30,000	British Electric Traction	10	... 6 % ...			17 — 18	17 — 18	17 1/16	17⅜
30,000	Do. do. 6 % Cum. Pref. 30,001—60,000	10	... ...			13 — 13½	12⅜— 13¼	13½	12¼
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	... ...			126 —129	124 —127 xd	...	...
45,000£	†British Electric Works Co., Ord. £1 shares, 50,001—95,000	...	... ...			7/8— 1	7/8— 1	...	...
50,000	† Do. do. 6 % Cum. Pref., 1—50,000 ...	...	... ...			7/8— 1	7/8— 1	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	... ...			99 —101	99 —101	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	... ... 20 %			11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	... ...			6 — 6¼	6 — 6¼	6⅜	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	3 % 5 % ...			1⅞— 2⅛	1⅞— 2	2	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % 6 % ...			2⅛— 2½	2⅛— 2⅜	2 3/16	2⅛
125,000£	Do. do. 4½ % Perp. Deb. Stock ...	Stock	... ...			108 —113	108 —113	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	... ...			103 —105	103 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½ % 15 % ...			14½— 15½	14½— 15½	15⅜	14⅞
20,000	Do. do. 5 % Cum. Pref.	5	... ...			5½ — 6	5½— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	... ...			112 —116	112 —116	...	...
213,533	Central London Railway, Ord. Shares	10	... ...			10 — 10⅛	10¼— 10⅜	10 9/16	10⅛
61,088	Do. do. Pref. half-shares	5	... ...			5 — 5⅛	4⅞— 5¼	...	...
71,447	Do. do. Def. do.	5	... ...			5¼— 5⅜	5 — 5¼	...	...
855,000	City and South London Railway	Stock	1½ % 2½ % 1⅞ %			67 — 70	67 — 70	68½	67⅜
37,000	Do. do. Ord. shares, Nos. 22,501 to 60,000 ...	10	... ...			4½— 5½	6 — 7	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	... ...			3½— 4	3½— 4	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	... ...			98 —101	98 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 % 6 % ...			2 — 2½	2 — 2½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	6 % 6 % ...			3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	... ...			93 — 95	93 — 95	...	...
112,100	Electric Construction, 1 to 112,100	2	6 % 6 % ...			2½— 2⅝	2½— 2⅝	2¼	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000	2	7 % 7 % ...			2⅜— 3¼	2⅜— 3¼	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	... ...			104 —107	104 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000 ...	2	... ...			⅜— ⅝	⅜— ⅝	...	...
9,600£	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 % 7 % ...			10 — 12	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 % 14 % 15 %			13½— 14½	13½— 14½	14 5/16	13⅛
12,000	Do. do. do. 4½ % Pref.	5	7 % 7 % ...			5¼— 5⅜	5¼— 5⅜	5 5/16	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %			110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 % 10 % ...			21 — 22	21 — 22	...	...
800,000	Do. do. do. 4 % 1st Mort. Debs.	100	... ...			100 —103 xd	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½ % 3½ % 3⅜ %			8⅝ — 8⅞	8⅝ — 8⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 % 5 % 5 %			12⅞ — 13⅛	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 % 15 % 15 %			36 — 40	36 — 40	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	... ...			102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000 ...	5	... ...			9 — 10	9¼— 10½	10½	10¼
20,000	Do. do. 5% Cm. Prf. Nos. 1 to 20,000 ...	5	... ...			5¼— 6	5¼— 5⅝xd	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	... 3 % 3 %			101 —104	101 —104	103½	102

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 105—108.
National Electric Free Wiring, 12/6 paid. 9—11.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17—18.
Do. do. Pref. (£10 pd.), 10½—11.
Smithfield Market Electric, 2—3.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7⅛. Debentures, 105—108. Dividend, 1899, on Ordinary Shares 11 %.
Kidderminster and District Electric, Pref. (£6 pd.), 6—6½.
*T. Parker, £10 (fully paid), 18.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (January 25th, 1900).

MARKET QUOTATIONS, Wednesday, April 4th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) ..	per ton	£34	£29	£5 inc.
a " "	per ton	£31	£27	£4 inc.
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£16 10	£16 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£26 10	£26 10	..
a Lead, Nitrate	per ton	£25	£25	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks ..	per lb.	4½d.	4½d.	..
a " Caustic (75/60 %) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	68/-	68/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a " Crystals	per ton	£3	£3	..
a " Bichromate, casks ..	per lb.	3½d.	3½d.	..

METALS, &c.				
Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b " Sheet, in ton lots ..	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£80 to £150	£80 to £150	..
c Brass (rolled metal 2" to 12") basis	per lb.	8½d.	8½d.	..
c " Tube (brazed)	per lb.	10½d.	10½d.	..
c " " (solid drawn) ..	per lb.	9d.	9d.	..
c " Wire, basis	per lb.	8¾d.	8¾d.	..
c Copper Tubes (brazed)	per lb.	11½d.	11½d.	..
c " " (solid drawn) ..	per lb.	11¾d.	11¾d.	..
g Copper Bars (best selected)	per ton	£89	£88 10	10s. inc.

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

METALS, &c. (*continued*).		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£89	£88 10	10s. inc.
g " Rod	per ton	£89	£88 10	10s. inc.
e " (Electrolytic), Bars ..	per ton	£85	£85	..
e " " Sheets ..	per ton	£94	£94	..
e " " Rod ..	per ton	£88	£88	..
e " " H. C. wire	per lb.	10d.	10d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f " Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha, fine	per lb.	8/-	8/-	..
h India-rubber, Para fine ..	per lb.	4/4 to 4/4½	4/4 to 4/4½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants)	per ton	77/3	75/1½	2s. 1½d. inc.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i " Wire galvanised No. 8 ..	per ton	£14 5	£14 5	..
g Lead, English Ingot	per ton	£16 17 6	£16 15	2s. 6d. inc.
g " " Sheet	per ton	£18	£18	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bottle	£9 12 6	£9 12 6	..
d Mica (in original cases), small	per lb.	3d. to 9d.	3d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p " r'l'd str'p & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 12	£3 12	..
p Silicium Bronze Wire	per lb.	10½d. to 1/-	10½d. to 1/-	..
i Steel, Magnet, ace'd'g to desc'p'n	p. ton	From £15	to £40	..
i Steel, Magnet, in bars		£58	£58	..
g Tin, block	per ton	£143 to £144 nom.	£140	inc.
g " foil	per lb.	1/9	1/9	..
n " wire Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles	pr lb.	8½d.	8½d.	..
j " Best Flax, 8 lea. ..	per lb.	6d.	6d.	..
j " Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j " " Russian, 10 lbs.	per lb.	5½d.	5½d.	..
j " Jute, 180 lbs. rove ..	per ton	£15 10	£15 10	..
k Zinc, Sheet (Vielle Montagne bnd.)	p.t.	£27 5 nett.	£27 5 nett.	..

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

SOME CONSIDERATIONS AFFECTING THE TRAINING OF YOUNG ENGINEERS.

By W. C. BORROWMAN, Wh. Sch.

(Abstract of paper read before the North-East Coast Institution of Engineers and Shipbuilders, at West Hartlepool, February 24th, 1900.)

(*Concluded from page 462.*)

There are always real pleasure and profit for a boy to be got from working with tools and amongst models, and if at the end of a year or so in such a place he should have learned little more than to know a plane and a file when he sees them, to be able accurately and scientifically to use his foot-rule and compasses; if by this time he has been able to train his hands and eyes to work in sympathy, he will have spent his time well, and be in some degree equipped to start an apprenticeship in any workshop he may be employed in. He will not thus learn his particular trade or art, but he will be helped materially to choose it, and thus pass on to its actual conditions by working at it. Such a training would also make provision for his introduction to theoretical knowledge, to sketching and drawing, and the grasping of details of construction. He will then know that an apprenticeship means far more than merely learning to chip or file. He will learn the time required to do certain work, the proper finish that certain work should have, the right and wrong way of handling such work, shop systems, the character of his fellow workmen. He will further begin to see that the development of manual without co-ordinate intellectual training forms only a small part of what will help him in the work that lies before him in the future. He will observe that the higher the standard of general intellectual culture he attains to the more solid will be the groundwork of all his after special instruction. He should, consequently, along with technical studies have some one other subject at least as a hobby. Let it be history, geography, philosophy, a foreign language—something which is outside his immediate business and not visibly related to it; something he takes to because he likes it for its own sake, because he knows that his character is enriched and strengthened by it, because it helps to give him a wider outlook upon the world of nature, of books, and of men, and because he may thus prepare himself better for the duties of a citizen and parent as well as fill an honoured place in the ranks of industry.

At one time so important did a knowledge of mechanical drawing appear to the French Government that the Commission on Technical Education concluded that, for the working classes, technical education meant merely instruction in mechanical drawing. In spite of all this, however, it is a notorious fact that a large percentage of British workmen cannot either make or understand a drawing. A knowledge of drawing would give him the power of putting his own ideas on paper, while it would also enable him to interpret the ideas of others, and much better than any spoken explanation could possibly do.

It is sometimes stated that the average Englishman is behind his Continental neighbours in the appreciation of art. Whether this is so or not, it is a fact that drawing is taught less and to fewer people in our English schools than it is in almost any other country having any pretensions in the way of education. In France, Germany, Belgium, Sweden, America, and in some of our colonies, drawing is compulsory, and has many hours each week devoted to its teaching.

In saying this it is not intended to cast any slur on our workmen, because, as Dr. John Inglis said the other day in his address to the Institute of Marine Engineers, "he is not, as an individual, inferior to his predecessors who brought the steam engine to its present state of efficiency," nor does he "believe that what he calls the 'uncontaminated' British working man is excelled or even equalled by the workmen of any other nation in skill or endurance whilst he is employed at his own particular handicraft. In the departments of work demanding physical strength and a certain quantity of conscientiousness, without which no important structure or mechanical contrivance can be properly executed, he is, when at his best, the most reliable in the world."

At a time like the present, when the effects of foreign competition are being so persistently brought before us and are attracting so much general attention, it is not inappropriate to our subject to consider briefly how some foreign nations stand as regards their means of educating their industrial classes, and the influence of such education on their manufacturing and other industries. While our system pins its faith to a shop apprenticeship combined with a simultaneous course of study at evening classes, on the Continent and in America their systems are based on the now recognised fact that a real apprenticeship, as indicated earlier in the paper, does not now exist. Whereas we prohibit all attempts at teaching trade methods in schools, and, where anything practical is attempted, it is only secondary and subsidiary to the theoretical and scientific instruction given, they have specially organised and graded courses wherein both theory and practice are conjoined and where specialisation in study is a prominent feature.

In France the present system of primary technical instruction has now had a trial of over 20 years, and is the outcome of a movement in favour of some type of school where trade classes could be taught. After a systematic investigation had been made, those in authority found that throughout the whole country craftsmen were becoming less and less skilful with their hands, and, looking about them for a reason, had little difficulty in seeing how this state of matters arose. It was seen that the same proficiency in handicraft could not now be attained as was possible formerly, because the latest systems of shop organisation and management were tending to consider a man as being simply the intelligent part of the tools he was employed to handle. It was further recognised that the ever-increasing tendency towards the sub-division of labour was making a few years' apprenticeship far too short to enable a lad to have experience in more than a few of the departments of instruction.

The French Government acknowledging all this, and that it was too much to expect any serious step being taken by the employers of labour to institute remedies to meet such influences, founded these apprentice or trade schools. That they have been successful for France we have abundant testimony, for whereas at first an approximately small portion of time was spent in practical work, now they have more and more practical work undertaken by the student-apprentices as they graduate through the various divisions of elementary, manual instruction, and higher grade schools.

In Germany the same system prevails, but in a more pronounced degree. Among the many causes that have tended to the phenomenal progress of German industry and commerce lately, we must acknowledge the advanced educational conditions upon which that country has placed so much faith for their development. It is recognised that, in these days of rapid intellectual progress, it is as possible for educational systems to become old-fashioned and out of date as it is for machinery and factories, and, while the facilities for affording technical instruction to workmen are perhaps not better than our own, the organised system of secondary education is as nearly perfect as it may be to meet the requirements of to-day, while those colleges whose detail and equipment are designed to afford facilities in original and independent research work in physical science are not equalled anywhere. Of course we must remember that Germany, like America, is comparatively recently in the field, and is making the best of all available sources of information. In the trade schools the instruction is essentially of a practical nature and provides a general preparation for an industrial life. They lead the way for a lad into the workshops and factories by giving him every kind of general and special knowledge, as well as habits of industry, while they, over and above this, go far to help him to choose his future calling. It has also frequently been shown that the instruction given in this way has helped to revive and develop several industries that otherwise might have died out. The grading of these schools is carefully defined, the instruction is strictly disciplinary, examinations are not too frequent, and as a consequence the study is broad and thorough. While with us technical instruction is as yet chiefly supplementary and is administered in separate courses, in Germany, as on the Continent generally, and in America, it is looked upon as of far more importance and as part of a great national educational system.

In Japan the development in every department of industry, and its effect on trade in the Far East, has come as a surprise to most people; but for several years now the Japanese have been studying the system of western nations, and are now, so far as educational matters are concerned, almost abreast of any industrial nation in the world. As showing the progress being made in technical education amongst the Japanese, it is interesting and instructive to note the curriculum laid down for the training of their engineering officials in the Imperial dockyards. There is as yet no organised system of apprenticeship or trade schools, but the courses followed by both officials and foremen are very advanced and thorough. The same rules apply equally to all departments of the navy, such as shipbuilding, ordnance, engineering, &c., and the training is graded into first, second, and third classes. The highest class of officials, those who ultimately become chief constructors and inspectors of machinery, ordnance, and such like, come under the first class, which is as follows:—Students enter the university, after examination, at ages ranging from 18 to 20, and remain there for six years, the first three years of which are spent studying higher mathematics, physics in all its branches, chemistry, drawing, &c. At the end of these three years, students have to decide which particular branch they intend to follow, and during the remaining three years they study the technical subjects appertaining to this branch. They also spend the summer vacation, of about four months' duration, in acquiring practical knowledge in the workshops and building yards of the dockyards. At the end of each year they are examined as to their progress, and the results of the five previous examinations together with the final examination at the end of the sixth year, decide to a certain extent their future prospects. They thus pass into the junior, or sixth grade of constructors. The minimum time required for promotion to the fifth grade is one year; two years are required for the next step, from the fifth to the fourth grade; from the fourth to the third grade requires five years; from the third to the second grade two years. These times are the minimum, and it might take an exceptional man to pass through all the different stages in the time mentioned.

The second class consists of those fitting themselves to be sub-inspectors of work and senior foremen. They enter as ordinary workmen, at ages varying from 16 to 20, and during that time certain of the more intelligent ones are selected for education in the dockyard schools and colleges. The period of training extends over four years, half of each day being spent in the schools and the other half at practical work in the workshops. During the first two years the tuition in school is confined to the subjects required for general education. They then decide which branch they are going to follow, and for the remaining two years the half days spent in school are devoted to those particular technical subjects appertaining to the branches selected. Examinations are held at the end of each year, and the results of these, combined with the result obtained in the final examination at the end of the fourth year, determine their order of promotion, &c. At the end of this time they qualify as minor officials, and go through ten grades, the minimum time for each of which takes one year, and the final grade is composed of senior foremen, sub-inspectors, &c.

The third class is composed of those selected from the ordinary workmen after they have reached the age of thirty years or so. Those

b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

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h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry G. Xee & Co.

m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

selected are allowed to go to the dockyard school during the half of each day for a period of three years, during the first 18 months of which they acquire an ordinary rudimentary education, and during the latter 18 months they learn certain principles and general technical information regarding the branch to which they belong. These likewise are examined at the end of each year, and at the expiry of three years qualify for positions of chargemen in the various departments.

The ordinary workmen, entering at the ages ranging from 16 to 20, serve no apprenticeship. As they acquire the requisite skill and experience, their pay is gradually increased until they get the current wages of the district for their particular trade.

We now understand why it is that fewer foreigners are now employed in Japan than used to be formerly, and why, except in such new industries as yet require the supervision of foreign experts, the services of foreigners are being more and more dispensed with. The Japanese see that if a nation is to be great its schools must be attended to, and that neither money nor time must be grudged for the erection, equipment and maintenance of such schools and laboratories of all grades.

Although it is now 60 years since a special Committee of Council was instituted in England to look into our educational system, it is just 30 years since any real activity and progress were commenced in technical instruction. Before this, although we were first among the nations in skilled labour, we were somewhat behind most of them in systems of technical education.

France, Belgium, Switzerland, and Prussia offered many advantages to young engineering students that England has not yet thought of. It was not until these countries, as well as Germany and America, began to profit by this that we took up the matter in earnest. At first it was the exception to consider engineering science as part of a collegiate course. It had not yet taken its place among the learned professions; at all events, it had not been recognised as such. There also existed great difficulty in securing competent men to take the place of instructors, not because there were none who had the requisite knowledge, but because there was a want of proper sympathy on the part of educational authorities. It was thought that having provided a class room and a blackboard the teacher should be able to do the rest; that having provided him with a sufficient supply of chalk, they had given all the support necessary to a chair of engineering. Luckily, in the face of such odds, good men were usually chosen to fill these appointments, men who came out of some works' department or drawing office, and with a very complete knowledge of the very things a young engineer requires to know. They had, however, to find out for themselves the best methods of teaching, whereby young students were trained in the principles of their business on the one hand, and whereby the members of the college board were educated up to a proper appreciation of the fact that very substantial aid in the prosecution of their duties was required on the other.

To-day this is all changed. The modern professor of engineering undertakes his duties as part of a recognised curriculum. His requirements and expenses in the matter of apparatus and books are known and accepted. He is no longer under the distasteful necessity of having to extort, almost by force, the requisite cash for his working expenses. He is usually a man whose theoretical knowledge has shot far beyond the usual requirements of the consulting room or drawing office, and who, after a subsequent successful career at college, and possessing certain academic tastes, has been chosen by his professor as demonstrator and assistant, and so makes his way to a professorship.

Except in a few instances he finds it impossible to make fame by means of any practical work, and to his credit it has to be acknowledged that he labours hard without the stimulating hope of making any great pecuniary gain. In research work, in the laboratory, he is at home, and has, in many instances, laid his practical brother deep in his debt; here he has chances that few manufacturing engineers ever meet, and he makes the most of them. He spares neither time nor thought in his experimenting, from which he evolves much useful information, and this he dispenses liberally. It would be difficult to estimate the amount of such information, much of which cannot be applied in its present form to our every-day requirements; but there it is, stored, until our increase in knowledge of it makes it directly useful. In such work he excels, and up to this point he is a good man, but laboratory work is distinctly limited; the moment experiments go beyond a certain dimension they are outside his province. The instruction he furnishes his pupils is most valuable, but it might be more so if he were to remember the nature of the work they will have to perform in their every-day life later, and because he is apt to view all his work through the eyes and from the platform of the professor and physicist merely. For corroboration of this, we have just to turn to the experience of one of our most successful science teachers. Prof. Kennedy confesses that if he were to take up teaching now after his experience in these later years of practical work, he would do it better and more successfully than he did do it when he was a professor and nothing more, a wider experience in the field of practice, and a closer intimacy in daily life with those young engineers whom he knew only as students before, being the reasons for this change.

The subject of foreign competition has already been alluded to, and while it cannot be classed as a strictly technical subject it is none the less a matter upon which it is as well that the rising stock of engineers ought to be well informed. It has often been the excuse for spending large sums of money on technical education, while it would be a perfectly fair question to inquire whether hitherto all the money so spent has been laid out to the best advantage. Foreign competition is not a thing of to-day or yesterday, but has now been with us for some considerable time. It had really been going on before we were aware of it. We came face to face with it 50 years ago at our first International Exhibition, when we learned for the first time that other countries besides our own were progressing in manufactures and claiming a share in supplying the world with their wares. It was then seen that our supremacy in the industrial race was being challenged, and that it was necessary to keep moving.

It will be shown that other influences besides technical education have been at work to help foreign competition, because if we consider Germany and America, our two greatest industrial rivals, we shall see that while Germany, as has been pointed out, has the most perfect system of education in the world, and it is held that her great progress has been entirely due to this fact, America, whose educational systems are not so perfect, has really to be reckoned with as a rival with far more apprehension. Again, too much importance should not be attached to the recent importation to this country and some of our colonies of large consignments of American machinery, locomotives, and bridges.

This old bogey, foreign competition, has again and again been exhumed, and we have urged, almost *ad nauseum*, the necessity of doing something to meet it, while the real facts were overlooked that American cheapness and quickness of delivery had in nearly every case been aided by a certain local and temporary conditions that really reflected credit than otherwise on British firms. The year that closed two months ago was one of unexampled activity and prosperity in every department of commerce; and if we remember that the conditions of international commerce have changed so considerably during the past few years, it should not be matter for surprise to find great development of two such nations as America and Germany. It is sometimes inferred that because these countries are earnestly bidding for part of the world's trade England is behind in her methods and too blind to see it. We are pointed to consular reports for proof of this, from which it might be concluded that England generally was going to the dogs. But we are not so conservative as we are sometimes said to be; and if all was known it would be found that the consular reports of every commercial country in the world were remarkable for the very complaints with which ours are so often filled. The British working man has not yet lost his cunning, nor the British trader his courage and enterprise, or how is it that so many young men from America and Germany, as well as from all parts of the world, come to study in our workshops, our warehouses, and our universities?

If a fair comparison were made it could be shown that the value of the foreign commerce of Germany when compared with that of Britain is usually very much over-estimated, and that although Germany is making enormous strides in many industries, more especially in those where superior knowledge and technical skill can be applied, we are as readily rising to meet them, and if it be true that in some instances America and Germany are able to outdo us, it is equally true that we are outdoing them in something else.

In comparing American with home engineering products they do not seem to possess the merit of being much, if any, cheaper, because machine for machine in many instances they are considerably dearer; nor does their construction seem to indicate any superior average intelligence or thoroughness in their workmen; nor where powerful, responsible, and reliable machinery is required, can it in any way be said they excel such English products. What they do excel in is the production of small things cheaply, and so we have our markets flooded with ingenious puzzles, Waterbury watches, sewing machines, agricultural implements, and all those things that are made by the thousand, similar in design, similar in structure. If we consider huge engineering structures it will be found that there are few countries where such terrible catastrophes have occurred, due to their failure, indicating a want of knowledge in such things, and very often a total disregard for first principles. Where such structures have been successful, they have been either actual English production or good copies of them. Whatever are the various factors that have tended to the almost phenomenal rapidity of advancement of our American competitors and of their almost daring developments of ingenuity and skill cannot be considered now, but there is no harm in reminding ourselves that partly, at all events, they are due to the fact that in America the people, to whose ingenuity such strides have been possible, are essentially English; and given a good parent, can any one doubt the possibility, when circumstances of environment and such like are suitable, of the children sometimes going one better, more especially when the parent stays at home and sends other children out to civilise and colonise the world.

LONDON COUNTY COUNCIL.

At last week's Council meeting Mr. W. M. Beachcroft asked the chairman of the Highways Committee whether it was intended to take any action in regard to the circular issued by the National Telephone Company setting forth the position of the telephone service from the company's standpoint.

Mr. J. W. Benn, in reply, stated that the Committee would submit a report in reply to the circular at the next meeting.

Action for Default in Supply.

The Highways Committee reported that the Greenwich District Board had adopted a resolution asking the Council to take action against the London Electric Supply Corporation in respect of failure to maintain a proper supply of electrical energy within the district, and a representation had been made on behalf of certain consumers as to the sudden failures of supply having been the cause of serious inconvenience and danger and injury to trade in the district. As a result of inquiry, the Committee stated they were satisfied that ground existed for the complaints. They were

informed that evidence was available of specific failures, of which record had been kept, of supply of current to the Goldsmiths' Company's Technical Institute at Deptford on nine days between January 10th and 24th, and the Committee thought that as regarded those cases of failure, the Council should take proceedings against the company in the public interest. There had been many other cases of failure of supply in the district, but no precise record had been kept, and the Committee stated that it might be difficult to obtain satisfactory evidence in support of proceedings if taken against the company in regard to those instances. The company's order of 1889 and the Board of Trade regulations made thereunder provide for the imposition, in cases of default, of penalties not exceeding 40s. a day under the order, and of £5 a day under the regulations. At the suggestion of the Committee, it was decided to instruct the solicitor to take proceedings to recover penalties against the company for default.

Another Loan Dispute Impending.

The Finance Committee reported having considered an application from the Shoreditch Vestry for sanction to borrow £96,000 in respect of the cost of erecting and equipping the proposed new generating station. It appeared that the sum required for building works was £32,095, but as the drawings were not completed, the Committee proposed at present to sanction £28,000. The amount for engineering works was £63,905, but as the Vestry had not yet decided upon the type of boiler to be employed and the arrangement of steam and other piping, the Committee suggested that £42,000 should be approved on account of engineering works. It was therefore decided, on the recommendation of the Finance Committee, to give sanction to the borrowing of a total of £70,000, to be repaid within 42 years, on condition that renewals and replacements were provided for during that period out of a sinking fund, or from maintenance account.

It was decided on the recommendation of the Building Act Committee, to approve plans submitted by Mr. C. S. Peach, on behalf of the St. James and Pall Mall Electric Lighting Company, for the erection of an extension of the generating station in Carnaby Street.

DUBLIN ELECTRIC LIGHTING EXTENSION SCHEME.*

By THOS. TOMLINSON, B.E.

In response to your invitation, I have much pleasure in laying before you a few notes on the proposed scheme for the extension of the electric lighting of this city.

The notice has been too short, and the time at my disposal too inadequate to admit of a very detailed criticism; this, however, I take it, you do not want; what you do want are notes of the points of the scheme as it affects your interests.

Your interests demand an electrical supply cheap, widespread, and available for all purposes; the interests of the citizens, whether as ratepayers—who do not want to have to meet a deficit, or as consumers of electrical energy or gas—who want cheap light and power (for it is a truism that cheap electricity means cheap gas) demand the same.

If the scheme is a good one for the citizens, you will be the first to find it good for you; if it is bad for the citizens, you will be the first to find it bad for you.

By reason, then, of your deep personal interests involved in the commercial success of the undertaking; of your technical training and experience; and particularly of your practical acquaintance with the inducements as to price necessary to secure a large and immediate connection of consumers; there is no body of men in this city better qualified to form an *à priori* opinion of the probable commercial success of the scheme proposed.

I take it that you are all familiar with the published description of the scheme, and that very slight references (and occasionally none) will suffice to connect my notes with the original.

The system is the generation of three-phase alternating currents at the Pigeon House—three miles off, I believe—and their transmission, at 5,000 volts, to the city; part of the supply is to be reduced to 2,400 volts. Single-phase currents at the existing station in Fleet Street, to feed the existing circuits, and part of it delivered (at 5,000 volts, and unchanged in phase) to 19 sub-stations outside the existing circuits.

I do not know whether there would or would not be any appreciable demand for power within the area already lighted, if it were available, but it seems to me likely that it would be greater inside that area than outside it. If this be so, then the proposed scheme presents this curious anomaly, that it proposes to generate the electricity in a form suitable for motor work, to change this into a form unsuitable for motor work in the district where motors would be most required, and to leave it unchanged in the district where they would be least required.

If this were unavoidable under the conditions imposed by the necessity of utilising the existing two-wire system, there would be no room for comment. But is it unavoidable? I think we shall find it is not.

The engineer leaves it an open question whether the generation of electricity shall be at 500 volts with step-up transformers, or at the full line voltage (5,000 volts), explaining that the latter will involve a saving of £6,000 in first cost. It is an open question, but I think that £6,000 cash, and, of course, extra running cost, can be saved.

If the station were running with the full 5,000 volts on the armatures, I should not anticipate trouble so much in that quarter as in the 76 (seventy-six) 5,000-volt transformers in the 19 underground sub-stations.

I have had experience of transformers at a fairly high voltage (2,500) hung out in the open—American fashion—and I have had experience of motors at a much lower voltage (1,000) shut up in unventilated pits, and comparing the failures under the two conditions, I feel pretty certain that the safe and continuous working of 5,000-volt transformers in underground chambers will not prove an altogether easy problem to solve. The danger arises from undissipated heat, and in my experience, filling the cases with oil is worse than useless.

Now as to the number of phases. For lighting only—and the proposed system is practically available for lighting only, since it will not be available for power where power, if required at all, will probably be required most—there is no advantage whatever in adopting two or more phases. Single-phase transmission, with three-wire distribution, is just as economical in copper as even three-phase (with common return), and very much simpler.

This system was offered to this city by the late Mr. J. E. H. Gordon (under whom I was then serving) nine years ago.

I have here the original plans; they are interesting as being the first in the United Kingdom in which the high tension single-phase sub-station system, with three-wire distribution, was submitted as a feasible commercial system which could be installed at the same price as the then universally advocated and used "transformer in every house" system with a large economy in cost over the latter.

After a heated controversy in the Town Hall, the Corporation—a highly estimable body of gentlemen, who naturally knew nothing whatever about the matter—decided for the old system as the best.

That decision has, I need scarcely tell you, been reversed long ago. The plans are interesting from another point of view. You will notice that the expected lamp connection is marked along the street frontages (these were the figures given to the contractors to work to). Now I can see from the positions of the sub-stations (built, or being built, to replace the old house-to-house system) that the actual lamp connection is entirely different. This is, of course, a common occurrence; but it suggests the reflection that there must be a very large amount of good cable annually unprofitably buried in accordance with plans of distribution based upon hypothetical demands which don't materialise.

I can speak feelingly on this point, for there is at Bray one continuous mile of distributing cable—laid right along the esplanade where anyone would expect a decent demand—which doesn't earn enough to pay a reasonable return on the taping; now I made the plan from which that cable was laid in that position. The sum of £19,724 is to be spent in distributing mains on some supposed demand, and laid on the solid system, too, in the proposed scheme.

I think the financial interests of a central station will in all cases be best served by laying distributing mains in the first instance only where you are certain of a big demand, by establishing feeder points (to be afterwards turned into sub-stations) widely over the district, and by laying in the more doubtful districts distributing ducts only, ready for cables to meet the demand as it arises. This will ensure, for a given capital sum, the maximum area from which to secure customers, and will minimise the amount of cable which contributes to the station balance-sheet only on the depreciation and sinking fund side.

This idea of meeting the demands as they arose over the whole district at the minimum capital cost has undoubtedly determined the policy of the Metropolitan Electric Supply Company (Electrical Review, March 16th, 1900, p. 451).

The company refused to adopt the sub-station system years ago as unsuited to their needs; they pioneered their whole immense district with a house-to-house system, keeping off all competitors. Now having collared this huge district, they are setting about adopting the sub-station system.

The carrying out of this policy involved an almost sinful waste of fuel; but I have little doubt now that it was good business; though I naturally didn't think so then.

Returning, now, to the consideration of the single-phase system. As offered to Dublin there was, as you see, a transformer in each branch of the three-wire distribution, and so there would have been no balancing; when experience proved this to be necessary, I devised the plan of feeding both sides from the same transformer; it was tried at Larne, and a description of the experiment appeared in the technical journals at the time. With this addition, the system was adopted by the City of London Company, and is perfectly successful for lighting only.

Nowadays I think no system can be considered adequate which does not supply power, which means that, for the future, we shall have to use either multiphase alternating current systems or direct current, or a combination of both—the former for transmission, the latter for distribution.

In the scheme we are considering, multiphase currents are used throughout, and we may limit ourselves to such cases.

The question is, Shall it be two-phase or three-phase? Looked at practically, it seems to me that if two-phase currents will serve, then three-phase currents are a needless complication, and needless complication is a thing to be avoided.

Whether they will serve or not depends upon the action upon your lighting circuits of the starting and stopping of such motors as may come on it.

From the fact that at the Wandsworth station the engineer of the County of London and Brush Company is about to instal a two-phase system for the supply of Camberwell and Wandsworth,

* Paper read before the Master Electrical Contractors' Association, Dublin.

first time that other countries besides our own were progressing

satisfied that ground existed for the complaints. They were

where another load is expected, I conclude that the two-phase system is satisfactory in this respect, for the engineers of the Brush Company are certain to have satisfied themselves on this point by actual trial.

The use of a two-phase system at Willesden by the Metropolitan Electric Supply Company does not help our judgment in the matter we are considering, because it is merely a question of transmission of energy from a single large generating station to five smaller ones, and any motor load (as, for instance, the motor generators for the supply of direct current at Whitehall) is under the control of the company's own servants; but I think we may fairly infer that in the judgment of the engineer responsible for the work, the saving in copper to be made by the adoption of the three-phase system is offset in practice by the increased complication in switches, fuses, cables, transformers, and then increased cost.

As Mr. Bailey, M.Inst.C.E. (the consulting engineer to the company, and a director of it) has had an experience of 20 years in the design, erection, *and running* of electric light stations, his views on the commercial value of simplicity are worth noting, providing, of course, that I am correct in my inference from his choice of two-phase currents.

There is a point with respect to two-phase, as opposed to three-phase currents, which I would like to submit to you. This is the facility with which they lend themselves to the conversion of an existing single-phase sub-station system (supplying light only), the distributing mains of which you do not want to disturb (as in Dublin), to a system supplying power. If the mains be grouped so that opposite phases are supplied to opposite sides of the streets, then you can supply power at the cost of bringing a main across the street.

With regard to the distribution of either two or three-phase currents, in those cases where you are laying the mains for the first time, and are not tied down to the utilisation of any existing two-wire system, you can, of course, as is proposed in this scheme, lay your distributors as three or four-core cables, and thereby effect a certain saving in copper; but copper is not the only item to be considered (even in the cable it is not the sole factor of cost), and I have very little doubt that in practice—with the single exception of a service designed mainly or wholly for power supply—the old two-wire concentric methods will prove the most economical, as it is certainly the simplest.

Now as to the finance of the scheme we are considering.

The Dublin system began supplying current September 23rd, 1892, and now carries the equivalent of 23,000 8-c.p. lights, including 81 public arcs charged at £25. Now you cannot, as is proposed, tack on to such a system 419 extra public arc lamps at £18 each and show a favourable balance-sheet.

The scheme is one which for its commercial success requires a large and immediate connection, hampered by an amount of public lighting to be sold under cost price, which will prevent the immediate substantial reduction in price which could alone secure the necessary connection.

It is a pity that a promising municipal enterprise which, handled judiciously, would certainly become in time a valuable asset, should be hampered by such an anticipation of its future earning powers.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

Argus writes:—The Corporation of this town have been duly authorised by private Act to supply electric light to all persons, &c., residing within their jurisdiction. The provisional order differs very slightly from the form of provisional order in the schedule to the Electric Lighting Act, 1899. A question has arisen whether the Corporation are, under these circumstances, entitled to supply electric light fittings (other than meters) to consumers. I shall be glad to know whether (*a*) there is anything in the Electric Lighting Acts to enable them to do so, (*b*) an action can be brought to recover the price of fittings already supplied.

*** Upon the above facts it would seem that in the absence of some provision in their charter to that effect, the Corporation cannot lawfully supply fittings, nor can they sue for such as are supplied. A corporation is not bound by nor can it sue upon contracts which are not within the scope of its constitution, or which by the provisions of any Act of Parliament relating to the corporation it is expressly or impliedly incapacitated from making. The question seems to be answered by the case of Leicester Corporation *v.* Hill, which was decided by a County Court in March, 1898. There the Corporation sought to recover the price of electric light fittings supplied by them. His Honour said: "I can see nothing in the Electric Lighting Acts which authorises the Corporation to supply anything but meters." He accordingly gave judgment for the defendants.

A. D. C. writes:—An electric supply company in this town has recently acquired statutory powers for the purpose of laying mains in the streets. In pursuance of the right so conferred, they employed a firm of contractors to make all the necessary excavations. Owing to the workings being improperly fenced and guarded a foot passenger fell into a trench and sustained severe injuries. As a claim for damages has been made against the supply company, I shall be glad to know whether they are liable under the circumstances.

*** Although as a general rule, where a person or a company employs a contractor to do work, the contractor is liable for accidents which arise through his own negligence, there is an important exception in cases where the doing of that work involves the execution of some duty either to the public or some third party. Thus, an electric supply company is bound to see that street works, &c., do not interfere with the comfort and safety of passers-by. This principle, which was laid down by Lord Blackburn in Angus *v.* Dalton (6 A.C. 740), and affirmed by Lindley, M.R., in Hardaker *v.* Idle District Council ((1896), 1 Q.B., 340) appears to apply so as to make the company liable in the case put by our correspondent.

ADMIRALTY ENGINEERING.

Having begun to really look into the question of water-tube boilers, and having found them wanting, the *Engineer* has commenced to examine into the whole question of Admiralty engineering, and finds at the outset that the present Admiralty policy is based on the supposition that by means of very high pressures, the weight of machinery may be kept low, and in pursuance of such policy, pressures have been raised until in the *Niobe* the boiler pressure is 290 lbs., the nominal pressure being 300 lbs., reduced to 250 lbs. at the engines, while pressures of 350 lbs. are employed in some ships. It is pointed out that economy, due to high pressure, is obtained by greater expansion, and that such being the case, and the size of an engine being governed by its low-pressure cylinder, there cannot be much advantage as regards weight of machinery if the economy of high pressure is to be secured, for high pressure necessitates greater strength of parts, and also demands probably an additional cylinder, and all the extra complication this demands to each engine. Our contemporary states that no one knows really who or what the Admiralty is, but it is surmised that it really consists of the permanent officials, who rule by tradition, and it is to this that what is objectionable in naval policy is due.

Doubtless the *Engineer* is right. It will continue so long as the Minister of the Navy has no sound knowledge of naval or engineering matters. We cast no reflection on the present Naval Minister or First Lord of the Admiralty, nor on his predecessors. We complain of the system which puts the first line of defence under the thumb of a minister who is himself absolutely in the hands of permanent officials, themselves out of touch with practice. Even if Mr. Goschen were a first-class engineer, he would have to go when the other party came into power, giving way, perhaps, to a successful bacon curer or a paper maker. We hold it essential that the Admiralty should consist of a committee of men of an age, say, from 30 to 60, who should be eligible to serve for a period of, say, six years at the outset, after which time a proportion should retire every two years, so that the Board should be continually refreshed from outside, and it should be a rule that not more than a third or a half of their number should be members of Parliament. By some such means the Navy administration would be in better touch with the country, and would not go to sleep, as it now does, while the power of the permanent officials would be curtailed.

Our contemporary does not find that Sir John Durston and Mr. Oram are correct in claiming that high pressures imply less weight. We do not think much of the saving to be effected by any rise of pressure above 100 lbs. We would prefer to secure the extra temperature that higher pressures involve by means of superheat. Sir John's own figures for economy show better results with lower pressures and lower speeds and smaller powers, all which are supposed to be against economy. The *Diadem* used 2·21 lbs. of coal per H.P.-hour at 3,318 H.P., 1·61 lbs. at 12,813 H.P., and 1·76 lbs. at 17,262 H.P. These are not extraordinary results, for the *Diadem* is fitted with economisers.

The *Edgar* class, with Scotch boilers, is compared with the newer cruisers with Belleville boilers, high pressures, and economisers. In the *Edgar* class at full power the engines weigh 91 lbs. per I.H.P., with a boiler pressure of 146 lbs. The engines of the *Diadem* weigh 100 lbs., with a pressure of 291 lbs., while the boilers of the *Edgar* weigh 202 lbs., and those of the *Diadem* weigh 197 lbs., a paltry saving of 5 lbs., which does not balance the extra weight of engines, and cannot be claimed to show much for the much vaunted lightness of the Belleville boiler; even at this it is uncertain if the figures include boiler room accessories, well known as so heavy in the case of Belleville boilers. There is practically no difference in the power per ton of boiler between Scotch and Belleville boilers, and what difference there is, is not always in favour of the water-tube type. The terrific priming of the Belleville boiler is stated to be the reason why such very high pressures are employed, so as to permit of wire drawing. Our contemporary still hangs on more or less to the Belleville boiler, despite its admissions from time to time as to its comparative failure in such a phrase as "the *Diadem* staggering feebly from port to port."

The *Edgar* class used 1·70 lbs. of coal per H.P.-hour. The *Terrible* and *Powerful* used up to 2·3 lbs., and never less than 1·71, averaging 1·77 at 18,000 H.P., and 2·11 at full power (25,774 H.P.). In the later cruisers with economisers as little as 1·73 lbs. were used at full power, but taken all round the old boilers are the more economical, and this is a serious consideration on long voyages, where the weight of extra coal soon overbalances the saving due to a few tons less of machinery.

So much has been made of the new boilers and of the high pressures, that it will be a surprise to many to find how little, or even negative, have been the results attained, and this quite apart from

Dublin.

phase system for the supply of Camberwell and Wandsworth,

the not very satisfactory results from Belleville boilers. A simple-minded contemporary asks us when we complain of the economiser being perched aloft in danger, whether we would have the ship go into action with the economiser at work? Now, is not this funny? When most needed, a part of the machinery must be drained of water and put out of action. As well start by heaving the high pressure cylinder overboard, followed by, say, the feed pump. But no matter what may be the faults developed in the Navy, nothing is allowed to get out that can be kept secret. Our enemies would gain very little by a full disclosure of all the defects and troubles, while our Navy would benefit by letting in light upon all the devious ways of officialdom. It is certainly strange that in the mercantile marine there are no such troubles with boilers as characterise naval practice. The only reason can be that our naval policy is not in the hands of men of the same capacity, or that if naval engineers have the capacity they are in some way prevented from making use of it. These things should not be. The country is in no mind to be sold to salve the feelings of permanent officials.

STEAM ENGINE TRIALS.

According to the *Engineer*, Prof. Weighton is exceedingly angry that his paper (which was dealt with in the Electrical Review for February 9th, 1900), was to some extent unfavourably criticised by our contemporary, and now the journal seems equally angry with the professor for daring to take umbrage. Our contemporary always assumes the *rôle* of infallibility, and takes a lofty tone in saying, practically, that the professor and his friends lack experience.

The trouble appears to be that the professor claimed his findings as of general applicability to all engines, which was, of course, asking too much. Albeit it should be the object of engine designers to find out how and why engines do differ so very much in behaviour. On this score it is certain that data are wanting upon the behaviour of different degrees of internal finish of steam engines, more especially in reference to the polishing of the internal surfaces of cast-iron, or even of first closing such surfaces by some rolling process. We believe few doubt that the great enemy to economy is the interaction of the steam and the cylinder metal, generally known as cylinder condensation—and that ought, perhaps, to be known as cylinder re-evaporation, if the real mischief is to be indicated in a phrase. In spite of this, however, we do not find very serious efforts are made to diminish the evil by careful design. It is some years since Mr. Michael Longridge, in one of his very able reports, pointed out how enormously such inside surfaces exceeded a possible minimum. One of the worst forms of inside surface was the deep cover projecting into the cylinder a long way beyond the facing joint and affording a double surface of projecting cover and cylinder bellmouth, on which the action complained of could take effect. In one instance the interior surface was three-fold what it might have been made. Two engines of the same dimensions by different makers ought not to show different results. When they do so, it is largely because such vital points in design are sacrificed to external appearance. Deep coned pistons with large nutted rods and recessed covers are serious offenders in respect of surfaces.

All the little storm that has arisen between the professor and his critics, turns upon the question of cylinder drop. An able steam engineer with whom we discussed the question, objects to any attempts to cure drop by making the low pressure cut-off earlier in order that the receiver pressure may be raised, on the grounds that it is a bad system to make steam by compression in the cylinder, or rather to make pressure for the low pressure cylinder to utilise. Work has been done by the steam in the first cylinder, and he would not put work into the steam to be given out again in the second cylinder. Having got his work he would stick to it.

This certainly seems a sound view. Now, practically it is found that with ordinary cylinder ratios an admission up to half stroke in the low pressure cylinder does not involve very serious compression during the remainder of the high pressure stroke, and there is some advantage gained as regards economy for the low pressure cylinder considered alone. As the whole working of steam engines is very much a question of compromise, it seems probable that a cut-off in the low pressure at or near one-half is just that happy compromise that gives no special prominence to any particular feature. Drop as shown by gap between combined diagrams is, of course, not a necessity. By screwing up the low pressure cut-off, if the designer has unwisely put one there to screw up, the receiver pressure may be raised so that no drop occurs at the high pressure exhaust, but the indicator diagram continues a regular curve to the toe, which is brought to a point, and the exhaust line from that point is really the steaming line of the low pressure cylinder. But it is this system of working which causes so excessive a compression curve, and though it makes pretty cards does not make for economy. As we have before stated, we should like to see experiments on piston and valve tightness, and also on the effects of variation of internal surface area and finish. Definite knowledge of these points is far more desirable than fine drawn theories upon cylinder ratios, which have never yet been shown to be so very important.

New Showrooms.—The Electrical Company, Limited, of Charing Cross Road, W.C., have, owing to increased business, found it necessary to take larger premises in Brighton, and have opened extensive showrooms at 134, North Street, for the convenience of their clients on the South Coast.

THE PRODUCTION OF LIGHT BY ELECTRICITY AND GAS.

By ED. C. de SEGUNDO, A.M.Inst.C.E.

The relative merits of gas and electric lighting have formed the subject of numberless papers and of endless discussions, without any satisfactory conclusion having been arrived at as to the superiority of either. As a rule, the subject has been treated by an advocate of one or other form of lighting. His ideas on the matter have been fixed, and the conclusion to which he intended to come has been present in his mind before he started his argument, and thus any argument that did not serve the purpose in view has been discarded automatically. A gas engineer will prove that the electric light, as obtained from glow lamps, is hopelessly dearer than the equivalent amount of light obtained from gas. The electrical expert, on the other hand, will prove in an equally convincing manner that the electric light is really cheaper than gas. Everyone is familiar with the well-known advertisement which sets forth that so many candle-power costs 20 times as much if produced by electricity as when produced by gas, and equally familiar by this time is the advertisement of an electric lighting firm which maintains that the opposite is the case. No doubt both are as right as they are wrong. They generalise from special cases, and thus their arguments become misleading.

For years the 5-foot gas burner held supreme sway. It was no doubt a great improvement upon the former methods of lighting, both for public as well as domestic purposes, but although the need of a larger lighting unit was felt, the ingenuity of those interested in gas lighting could for some time rise no higher than the conception of a cluster of burners, and as long as nothing threatened the gas burner seriously there was no incentive to improve its status. When the electric glow lamp first made its appearance (in its original or rudimentary form) no one anticipated any development beyond the limits of the physical laboratory, and, indeed, but for the successful development of the dynamo, it is highly probable that the incandescent lamp would have remained a scientific toy. However, as circumstances also conspired to stimulate inventive faculty in the direction of producing a practical form of incandescent lamp, a very large number of practical men devoted their time and energy to the improvement of the glow lamp, with the result that finally the glow lamp and dynamo began to take some definite shape as a means of producing light. Gas engineers laughed the new illuminant to scorn, and, indeed, even now no self-respecting gas engineer will admit that the electric light has seriously affected the gas industry, but he will maintain that, on the contrary, on every side the capacity of gasworks is being increased. This is true, but, at the same time, it is not good evidence that the electric light is not competing with gas as an illuminant. It is impossible to read the reports of the annual meetings of electric supply companies without realising that the use of the electric light in private houses and for public lighting is steadily gaining ground. One must not forget that even now the electric light is very young compared with gas lighting, and it has been hampered by all the difficulties besetting the path of a pioneer industrial undertaking; the price of the current has been high, and is still high, compared with what it might be; then the electric light had to be introduced into existing houses already fitted with gas, and the expense of the electric installation fell upon the tenant, who, in many cases, thoroughly appreciated that in putting in the electric wires, he was improving the landlord's house, for which philanthropic act he would never receive even a word of thanks, and this was a very real stumbling block to the introduction of the electric light. In the face of these two drawbacks alone—not to speak of the vagaries that characterised electric supply in earlier days—the headway that the electric light has made is a proof of the hold that electric light took upon the public from the first, owing to the many undisputed advantages possessed by it over any other form of illuminant for domestic lighting.

Electric light is not yet the poor man's light, but that is no reason why, in the future, even Rowton houses should not be lighted by electricity. The question of cost is really one

which is easily dealt with by a growing demand, and when the electric light industry is half as old as the gas industry now is, it would not be surprising to find that the price at which electrical energy is then supplied would compare very favourably with the present price of gas. I do not suggest that the two industries are really antagonistic; indeed, the contrary would appear to be the case, but a consideration of this point would lead to too wide a digression.

In the current number of *Feilden's Magazine* a table is given, from which at first sight it would appear that oil lamps and gas burners are most expensive as compared with the electric light. It is stated that for the production of 1 C.P. 68 watts are required in a gas burner, 70 in an oil lamp, $2\frac{1}{2}$ to $4\frac{1}{2}$ in an incandescent lamp. Of course the technical man is not misled by this, but the average reader of the magazine would not readily recognise that although an amount of heat proportional to the number of watts quoted no doubt is consumed in the production of 1 C.P. in a gas burner and in an electric lamp, the gas burner does not feed on watts any more than the electric lamp would light up if attached to a gas bracket, and that the matter of expense comes in in the transformation of energy into the requisite form.

Then, again, in most comparisons that the author has seen, a 60-watt lamp is assumed to consume 60 watts and to yield 16 C.P. during its life of 1,000 hours, and similarly a 5-foot gas burner has been assumed to be always of standard efficiency. Further, in speaking of candle-power it has always been assumed that the electric incandescent lamp and the gas burner of ordinary type are strictly comparable as light producers, whereas the ratio of horizontal to mean spherical illumination is greater for the gas flame than for the electric glow lamp, and if by "candle-power" the horizontal candle-power is meant, which is usually the case, the electric glow lamp is placed at a disadvantage in the comparison. Again, variations in the pressure of gas do not injure the burner, whereas variations in the E.M.F. greatly influence the life of an electric lamp. Experiments have shown that the life and efficiency of an electric glow lamp, the current supply for which is drawn from a storage battery, is a very different thing indeed from its life in a house supplied from the mains of a company in which the voltage varies considerably. It is well known that on board some ships electric lamps are found to last a very long time as compared with the average life in electrically-lighted houses, the reason being that in such cases the majority of the lamps are lighted up at the same time and continue alight for long periods, in some cases for the whole voyage. The load being practically constant, there is little difficulty in keeping the voltage constant, and there is comparatively little switching on and off.

Another important matter in connection with electric glow-lamp lighting is the watt efficiency at which the lamps are used. At an efficiency of 4·5 watts per candle from accumulators, an electric lamp may easily last 2,000 hours before it loses 25 per cent. of its original candle-power, whereas if burned at an efficiency of 3 watts per candle, its useful life* would probably sink to less than a quarter of this period. The determination of the economical efficiency at which to run an incandescent electric lamp thus becomes a question of the cost of lamp renewals *versus* saving on the electric light bill. Sometime ago I made a few experiments on over-running some Robertson high efficiency lamps. If a 3-watt per candle 95-volt lamp be placed on a 100-volt circuit, it will be found that the saving in cost of current becomes equal to the price of the lamp after about 95 hours. The experiments were not sufficiently extended or complete to be conclusive as to results, but they were interesting in that they showed that if the cost of electric supply is over 6d. per unit, it would be an economy to use high efficiency lamps and *cæteris paribus* the cheaper lamps become, the more marked is the economy and the lower does the price per unit become at which it is economical to overrun the lamp. These remarks apply to 100-volt lamps. A numerical example will serve to illustrate the degree of economy to be effected. In the experiments above alluded to, a 95-volt 12-C.P. high efficiency lamp (3-watt per candle Robertson) was burned upon a 100-volt circuit. The resistance of the lamp hot was about 264 ohms, and the current which would pass on a 100-volt circuit may be taken as about 0·38 ampere. In these circumstances the initial efficiency may be assumed to be $2\frac{1}{2}$ watts per candle, or the candle-power $\frac{38}{2{\cdot}5}$ = say, 15 C.P. The candle-power, of course, would decrease more rapidly than that of lamps burning at a lower efficiency. It would be fair to assume that the mean consumption of energy during its useful life would be 3 watts per candle. The cost of the lamp was 1s., and taking the price of energy at 6d. per unit, the saving of current by using the lamp at a high efficiency would balance the cost of renewals if the life of the high efficiency lamp be x hours in the following equation:—

$$\frac{x \text{ hours} \times (4{\cdot}5 - 3\,0) \times 12 \text{ C.P.} \times 6\text{d.}}{1{,}000 \text{ watt-hours}} = 12\text{d.} - y, \quad (1)$$

where 4·5 is the watt efficiency assumed per candle for a lamp of 1,000 hours useful life, and y is the proportion of the cost of the renewal of the 4·5-watt per candle lamp for the life, x, of the high efficiency lamp. We therefore have, as the proportion to be deducted for renewals which would be incurred if the low efficiency lamp were in use :—

$$y = \frac{12}{\frac{1{,}000}{x}} \text{ or } y = \frac{12\,x}{1{,}000}. \quad (2)$$

Resolving, we get

$$108\,x + 12\,x = 12{,}000, \text{ or}$$
$$x = 100 \text{ hours.}$$

Thus if the high-efficiency lamp have a useful life of only 100 hours, it will pay for the extra renewals as compared with the low-efficiency lamp. Should the high-efficiency lamp last 200 hours, which is not a very extravagant assumption, the net saving would be approximately

$$\frac{12 \times 1{\cdot}5 \times 100}{1{,}000} \times 6\text{d.}$$

or nearly 11d. after paying for extra lamp renewals, as compared with the low-efficiency lamp, and the total cost of $200 \times 12 = 2{,}400$ candle-hours, including the price of the lamp, would be

$$\frac{2{,}400 \times 3}{1{,}000} \times 6\text{d.} + 12\text{d.} = 4\text{s. } 7\text{d.}$$

or $\frac{55\text{d.}}{24}$ = nearly 23d. per 1,000 candle-hours, as against

$$\frac{2{,}400 \times 4{\cdot}5}{1{,}000} \times 6\text{d.} + 3{\cdot}4\text{d.} = \text{nearly } 5\text{s. } 8\text{d.},$$

or $\frac{68}{24} = 28{\cdot}3$d. per 1,000 candle-hours, including the proportion (3·4d.) to be added for renewal.

(To be continued.)

* By useful life is meant the period which elapses before the candle-power is diminished by 25 per cent.

SOME ELECTRIC LIGHTING FIGURES.

HAVING regard to the progress that has been made in electric lighting during the past few years, it is not uninteresting to examine the results that have been achieved in the case of a few London companies, and of two provincial electric lighting concerns. For the purpose of this article it is unnecessary to refer to what has been accomplished by municipalities, the idea being rather to look at the commercial side of electric lighting, or rather from the dividend standpoint, this being impossible with municipal accounts. Half a dozen London companies have been selected for the purpose of these figures, and it is probably unnecessary to give more, because the list is fairly comprehensive as regards different districts. From a shareholder's point of view, any figures relating to the City of London Electric Lighting Company are in the present stage of the company's affairs somewhat melancholy reading. Taking the results of the last three years the net profit has fallen from £87,000 in the year 1897 to something over £60,000 in 1899. 1898 also witnessed a considerable drop in the profits, the sum realised then being £77,000. The dividend has naturally suffered in similar proportion, the excellent dividends of 1897 of 10 per cent. having fallen to the somewhat moderate one of 4 per cent. The capital expenditure has increased from £1,300,000 in 1897 to £1,500,000 in 1899. The lamp

clients on the South Coast.

be lighted by electricity. The question of cost is really one

connection has increased very largely, the figures three years ago being 296,000 against 429,000 in 1899. There is no doubt that the small dividend of last year was partly to be accounted for by the considerable reductions in the price of electricity which were made by the City Company in face of the expected competition with the Charing Cross and Strand Company; but though the City Company may deserve a certain amount of sympathy on account of the peculiar and somewhat arbitrary clauses in their provisional order, which compels the allocation of large sums to the reserve fund, it is clear that the large dividend of 1897 could not have been paid if high charges for electricity had not been maintained. For the purpose of comparison we have ventured to apply another set of figures to the operations of the company, namely, units sold per £ of capital expended. Objection may be raised to these on the grounds that they take no account of the large increased expenditure which has not arrived at a profit-earning stage. The answer to this is, if a company is carrying on its business and developing it on proper lines there will always be a certain amount of capital expenditure which at the time of issue of any balance-sheet could not be shown to be earning profits. Unfortunately, the figures of the City Company are not sufficiently complete to enable us to apply this test to the three years' operations; but neither as regards lamps connected, nor units sold, do they compare at all favourably with any company in London. With one exception they sell the fewest units per £ of capital expended of any company in London, and the lamp connection per £10 of capital expended is the lowest without exception. In 1897 the lamps connected per £10 was 2 2, yet it was the best dividend-earning year the company had experienced. The Metropolitan Company has gradually increased its capital expenditure from £850,000 in 1897 to £1,224,000 in 1899. Its net profit fell off somewhat in 1898, but the net profit for 1899 shows a material increase. It is well known that the Metropolitan Company has suffered in a marked degree from what we may term non-profit-earning capital, which has been invested in the form of large works at Willesden that have only been recently put on the circuits. Yet in spite of this the units sold per £ of capital expended does not show so marked a falling off in 1898 as one might have expected. The numbers sold in 1898 were 6·8, the figure being 6·6 last year. The causes we have already mentioned demonstrate why the lamps connected per £10 capital expended show a falling off. Probably the most interesting figures of any of the supply companies are those of the Westminster and St. James's and Pall Mall Lighting Companies, and yet there is a considerable difference in the way they earn their money. The Westminster Company has not paid less than 12 per cent. since 1897, and last year it paid 13 per cent., while the St. James's Company has maintained a steady 14 per cent. for the three years. The increased capital has not been exceptionally heavy though the Westminster Company's capital expenditure is more than twice that of St. James's, and it had very nearly three times as many lamps as the St. James's Company; yet it only supplies 50 per cent. more current.

A study of the figures at once shows how favourable the position of the St. James's Company is, compared to others in regard to the consumption of electricity per lamp. Applying the new figures we have tabulated, the St. James's Company sell 13 units per £ of capital expended; while the Westminster Company sells only nine. Yet the former has only five lamps connected per £10 of capital expended, and the Westminster Company has six, which demonstrates in a striking manner that the St. James's Company have a much better class of consumers. The Kensington and Knightsbridge Company, like the Notting Hill, shows a steady increase all round, and it pays 1 per cent. more in the dividend than in 1898; it has increased its capital

SUPPLY COMPANIES

	Capital expenditure.			Net profit.			Dividend.			Allocated to reserve or depreciation account.		
	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.
	£	£	£	£	£	£	%	%	%	£	£	£
City of London Electric Lighting Company ...	1,513,456	1,374,689	1,318,574	60,600	77,767	87,022	4	6	10	23,000	20,000	22,000
Metropolitan Electric Supply Company	1,244,000	993,000	850,000	53,000	40,000	43,000	5	5	6	13,000	13,000	15,000
Westminster Electric Supply Corporation ...	683,568	626,365	560,388	*34,668	*28,033	...	13	12	12	21,000	18,426	...
St. James's and Pall Mall	317,283	263,046	231,895	31,834	29,890	30,921	14½	14½	14½	12,000	10,517	9,269
Kensington and Knightsbridge Company ...	273,813	263,481	252,162	19,201	...	7,263	11	10	10	4,000	5,408	8,061
Notting Hill Electric Light Company	137,350	128,003	113,184	10,360	7,251	3,884	7	6	6	1,550	875	1,000
Hove Provincial Electric Lighting Company ...	93,660	77,450	66,896	7,097	5,089	3,602	7½	6½	5	2,000	1,000	...
National Electric Supply Company (Preston) ...	93,350	77,960	70,200	...	...	...	9 6	6 9	..	1,648	1,123	...

* After allocating depreciation.

	No. of units sold.			Lamps connected.			Units sold per £ of capital expended.			Lamps connected per £10 of capital expended.		
	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.
City of London Company	...	6,895,667	...	429,628	355,825	296,012	...	5 01	...	...	2·6	2·2
Metropolitan Electric Supply Company	8,300,000	6,800 000	...	500,000	430,000	360,000	6·6	6·8	...	4	4·2	4·2
Westminster Electric Supply ...	6,329,554	5,065,195	4,355,781	421,445	339,986	290,561	9·2	8	7·7	6·2	5·4	5·5
St. James' and Pall Mall	4 201,104	3,448,858	3,028,242	164,750	142,853	126,827	13·2	13·1	13·1	5·2	5·4	5·4
Kensington and Knightsbridge ..	2,463,950	2,081,074	1,898,362	183,462	156,158	137,955	9	7·5	7·5	6·7	5·8	5·0
Notting Hill Electric Supply Company...	665 129	455,871	354,969	59,154	46,066	33,000	4·3	3·5	3·1	4·3	4·0	2·9
PROVINCIAL.												
Hove Electric Light Company ...	444,499	350,254	263,243	44,892	36,967	27,777	4·7	4·7	4·0	4·7	4·7	4·1
National Electric Supply Company (Preston)	601,519	448,037	371,301	40,102	30,850	...	6·4	5·7	5·3	4·2	3·6	...

* By useful life is meant the period which elapses before the candle-power is diminished by 25 per cent.

per cent. The capital expenditure has increased from £1,800,000 in 1897 to £1,500,000 in 1899. The lamp

expenditure by £10,000, and it has contrived to bring up the units sold per £ of capital expended from 7·5 to 9. It has also increased somewhat the lamps connected per £10 of capital expended. The Notting Hill Company probably shows better than any concern in London the vitality of the electric lighting business; for when this company started, many pessimists urged that it would never show much in the way of profit. Yet after a steady dividend of 6 per cent. it has been able to declare 7 per cent. for 1899, although the number of units sold per £ of capital expended are far and away the lowest of any company in London; the figures being 4·8, which compares very unfavourably with the 13·2 of the St. James's and Pall Mall Company.

The figures of the Hove and the National Electric Light Companies are interesting, in so far that they show there is no very striking difference between the electric lighting business of the metropolis and the provinces. There is, however, a curious closeness in the capital expenditure of the two provincial companies we have selected, but the northern company shows considerable advantage in the units sold per £ of capital expended.

THE CONSTRUCTION OF OVERHEAD EQUIPMENTS.

(*Continued from page* 431.)*

IV.

The breaking stress of ordinary annealed iron wire is 25 tons per square inch of cross-section. Bessemer steel wire breaks at 40 tons, mild Siemens-Martin steel at 60, improved ditto at 80, while crucible steel and improved ditto break as high as 100 and 120 tons per square inch. The choice of material and of strength is thus very wide. The higher price of the stronger wire would justify less of it being used, but, if the waste due to corrosion is great, the wire must be larger, and it is false economy to use a span wire both expensive and thick when a cheaper grade will have already a large margin of strength.

In the ordinary way span wires are only exposed to the load of the trolley wires. They are not called on to bear any stress in the direction of the length of the trolley wire, for this is all dealt with, or should be, by special anchor wires. The latter consist of steel stranded ropes, similar to the span wires, that are extended from special anchoring ears at a span wire to the next pair of poles away from the direction of stress. Such anchorages are needed at the top of gradients to carry the down-pull, which may be considerable.

On a hill of 400 yards there are 10 trolley spans of 40 yards each of 90 lbs. weight, or a total of 900 lbs. On a gradient of 1 in 20, this is equivalent to a pull down hill of $\frac{900}{20} = 45$ lbs. to be provided for by anchor wires. Termini also require to be anchored, the end of a line being usually provided with a specially heavy anchor pole.

Span wires and anchor wires are attached to poles by wrought-iron straps, as in fig. 19, slipped over the pole top and clipped by bolts, one of which holds the strap firmly to the pole, and the other serves as the pin for the wire attachment. Trolley wires are attached to span wires by specially insulated hangers, and there are insulated tightening bolts, technically known as *strains*, between the span wire and the pole. The trolley wire is thus doubly insulated from the poles.

* Erratum.—By a slip in fig. 16, page 431, the distances y_1 and y_2 were wrongly shown. They should have been as under, or the distance from point of suspension to the lowest point of the wire. Fig. 15 for the Catenary is correctly drawn.

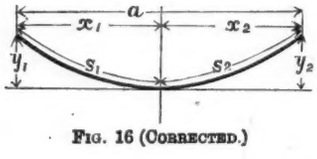

Fig. 16 (Corrected.)

The hanger consists of a bolt which is fixed to a gun-metal casting by means of a moulded piece of insulating material. The casting carries two lugs which hook upon the span wire, and the span wire loops round the wide part of the casting, and is thus firmly held. A special tool is used to attach the castings to the taut wire. To the insulated

Fig. 19.

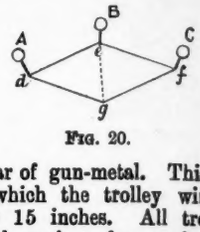

Fig. 20.

bolt is screwed a long grooved ear of gun-metal. This is a semi-circular-grooved bar into which the trolley wire is soldered. Its length is usually 15 inches. All trolley-wire attachments are made with various forms of these ears. Some are plain, for attachment simply to the plain hanger, others have special holes and lugs to serve as splices to join lengths of trolley wire together; other ears again have holes for attaching feeder wires whilst plain ears are used for holding pull-offs. These are special attachments for the holding of pull-off wires, for the purpose of pulling a length of straight trolley wire laterally to an angle or to a polygonal form so as to sufficiently approximate to the form of the curve of the rails below. At every such attachment to the trolley wire and to poles insulators are inserted. The usual form is a globe of insulating compound moulded over two interlocked eyes which are kept apart by the material. Failure of the material simply allows the two eyes to come together; no breakage of the line occurs, though, of course, the insulation fails. Before a trolley wire can be earthed there must be a failure of the two insulators interposed between it and the pole.

Trolley wire is only put up in continuous lengths of about 880 yards. At each such length or section, a section insulator is placed between the two lengths of wire. These insulators resemble a long ear, of which the middle is formed of bars of wood. At these insulators each trolley section is supplied with current by feeder cables. In putting up trolley wire the drum on which it is wound is mounted on a dray or special reel waggon fitted with a brake to check the rotation of the reel. One end of the wire is anchored to the poles next beyond the section insulator, and the reel waggon is drawn forward by a horse at a slow speed, the wire being kept sufficiently taut not to hang in loops too near the ground. Behind the reel waggon the tower waggon follows at about 40 yards, and as each span wire is passed the trolley wire is hung freely to it by means of little S hooks. When half-a-mile has thus been reeled out, it is seized by what is known technically as a *come-along* clamp, which holds the wire firmly, and can itself be hooked to a set of three sheave blocks by which the wire is drawn up tight and temporarily anchored.

In order to take the stress off the section insulator the suspension ears at the span wires next to the insulator, *i.e.*, at the next pole, are made anchoring ears, and anchor wires extend from these to the section poles. These section poles are thus anchor poles and should be somewhat stiffer than ordinary poles. It is, of course, necessary to interpose two insulators in the course of each anchor wire in order to place their insulation on a par with that of the span wires. The section poles, as already said, are also feeder poles, and serve to carry the four feeder cables that connect to the four trolley wires attached to the two section insulators.

The feeder cables are carried up the interior of the feeder pole; only one pole is used for the purpose, the cable track being on one side only of the road. These feeder cables are taken into the pole from the feeder box, usually placed about 4 feet away from the pole. They enter by holes or slots, and emerge in similar manner through holes near the top of the pole, whence they are carried along the span wire to the section insulator. The feeder box is fitted with switches by means of which each feeder cable can be cut out, and a length of trolley wire may thus be made dead by opening its feeder switches in the boxes at each end of the section. The main feeder cables are also brought up into each box to suitable switch terminals, and can be switched out at will.

The span wire system of suspension, now briefly described, is the best for running purposes, possessing great elasticity

and permitting the easy running of the trolley wheel without shock or sparking. It is also the least obstructive in the streets, and much to be preferred on all accounts to the side bracket system, which cannot be carried out without the use of sometimes excessively long bracket arms, and often even these cannot be used, but span wire poles must be employed.

In the bracket arm system the arms consist of very stout steel tubes nominally 2 inches diameter internally, but actually about 1⅞ inches. They are screwed into cast-iron clamps and then are clamped upon the poles. The arms are supported by one or two tension rods extending from the arm at various distances to a point nearer the pole top than the arm clamp. Below the arm the angle between pole and arm is filled with light wrought-iron scroll work. This is supposed to be beautiful and has a singular attraction for mayors and aldermen. It is only when brackets are short, double, and upon poles placed along the centre of a road that they have any good appearance. They are then about 5 feet long, and this projection is fairly proportionate to the length of pole and free from the bad effect of long bracket arms. Poles with brackets require to be raked very much, as when they carry span wires; the weight of the bracket arm and the 90 lbs. of wire and hangers hung upon it having considerable effect in pulling over the pole top. Round curves, where the poles are on the concave or outer side, the pull of the curve adds itself to that of the load and increases the necessary rake back on the poles, but when on the convex or inner side of the curve the wire tension helps to counteract the weight of the bracket arms.

For constructive purposes, and especially the attachment of pull-off wires, the outside position should always be chosen if possible despite the greater stress upon the poles. Indeed, when placed on the inside of curves of small radius the curve can only be worked round by using a wasteful number of poles set close together, whereas with the poles on the outer side the curve can be pulled off very neatly by wires from the adjacent poles. The pull-over stress on a pole due to the curvature of the wire may thus be calculated graphically:—In fig. 20 let A, B and C be three poles upon a curve. The stress upon pole B is to be obtained by laying out the wire to scale in its correct position, *d e f*, and completing the parallelogram, *d e f g*. Then to the same scale that *d e* represents the tension in the trolley wire, so will *e g*, the diagonal of the parallelogram, represent the lateral pull on the pole. So, too, with the vertical load of the trolley wire. In fig. 21 let W be this load, let

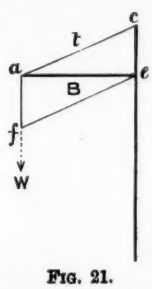

Fig. 21.

t be the tie rod, and B the bracket arm. Complete the parallelogram *a c e f*. Then if *a f* = 90 lbs. so *a c* to the same scale will be the pull on the tie rod *t*, and *a e* will be the thrust along the arm. The effective lateral pull upon the pole as a whole is as the ratio of the arm length and the distance from the ground to the bracket arm. Thus if an arm be 5 feet long and 20 feet above the ground the pull on the pole will be $\frac{90 \text{ lbs.} \times 20}{5}$ = 360 lbs. Long bracket arms are thus, apart from their own weight, which may be similarly calculated, fully as severe on poles as span wire stresses. An ordinary bracket arm alone without any scroll work weighs about 5½ lbs. per foot. A 20-foot arm thus represents a weight of 110 lbs. acting at a lever arm of 10 feet, or 55 lbs. at the end of the arm in addition to the 90 lbs. of trolley wire. This total of 145 lbs. includes nothing for scroll work, which will probably bring up the total to nearly 200 lbs. at 20 feet leverage. No reliance is to be placed upon the grip of the arm clamp to the pole or of the pole in its concrete bed, but anchorage must be provided against all longitudinal pull on the trolley wire. It may frequently happen that a direct terminal anchorage cannot be had, and the anchor wire must be taken singly and diagonally to the next side pole in exactly the same way as double anchors are taken to both span poles. An anchor has thus a resultant pull upon the anchor pole inwards to the street and of the pole at the anchor ear outwards from the street. So far as possible these various pulls are taken into account in raking the poles and choosing their strengths.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1900.

Compiled expressly for this Journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

5,146. "Improvements in or connected with fittings for electric lighting." F. Shaw and F. Greenfield. Dated March 19th.

5,154. "Improvements in electric traction." S. G. Bennett. Dated March 19th.

5,167 "Improvements in and relating to alternating current electro-motors," J. Yates, W. Yates, and J. B. Bent. Dated March 19th. (Complete.)

5,178. "Improved means for connecting electric cables." C. A. Day. (J. G. White, United States.) Dated March 19th. (Complete.)

5,183. "Improvements in electric locks." H. E. Newton. (H. G. Carleton, United States.) Dated March 19th. (Complete.)

5,184. "Improvements relating to electric tramways." F. B. Aspinall and A. J. Ireland. Dated March 19th.

5,187. "An automatic telephone-call recorder." A. E. Lamkin. Dated March 19th.

5,191. "Improvements in electric heating systems for cars." The Westinghouse Brake Company, Limited. (F. C. Newell, United States.) Dated March 19th.

5,196. "Improvements in simultaneous electric telegraphy and telephony." C. Adams-Randall. Dated March 19th.

5,216. "Improved manufacture of filaments for electric incandescent lamps." A. J. Boult. (A. Blondel, France.) Dated March 19th. (Complete.)

5,221. "Improvements in the distribution and collection of current for electric traction." G. Davis. Dated March 19th.

5,232. "Improvements in storage batteries." P. Kennedy. Dated March 20th. (Complete.)

5,252. "Improvements in apparatus for controlling and regulating electric motors." L. Higginbottom, J. H. Hindle, and T. Mannock. Dated March 20th.

5,257. "Improvements in apparatus for winding or producing coils, bobbins, helices or the like, such as are used for electrical purposes." W. G. Heys. (J. Scott, R. Varley, and J. C. Anderson, United States.) Dated March 20th. (Complete.)

5,274. "An improved process of and apparatus for the electro-deposition of metals." W. Y. Buck. Dated March 20th. (Complete.)

5,293. "Improvements in or connected with lead presses for making plates for electric accumulators and the like." W. P. Thompson. (Accumulatoren and Electricitäts Werke Act. Ges., vorm W. A Boese & Co., Germany.) Dated March 20th. (Complete.)

5,294. "Improvements in electric bells." W. R. Wynne. Dated March 20th.

5,321. "Improvements in plates for storage batteries." H. J. Haddan. (C. A. Lindstrom, J. Hewitt, and T. Hewitt, United States.) Dated March 20th. (Complete.)

5,327. "Improved system of distribution and collection of current for electric traction." G. Davis. Dated March 21st.

5,353. "Improvements in electric traction." E. H. Tyler. Dated March 21st.

5,356. "Improvements in or relating to electric cables." R. K. Gray. Dated March 21st.

5,361. "An improvement in lamp caps for bayonet socket electric lamp-holders." E. G. Sheppard and Nernst Electric Light, Limited. Dated March 21st.

5,376. "Improvements in electrodes for electrolytic purposes." E. Hopkinson and A. T. Smith, Jun. Dated March 21st.

5,387. "Improvements in apparatus for wireless telegraphy." G. Marconi. Dated March 21st.

5,389. "Improvements in and connected with electrically operated railway signals." J. Shoecraft and C. C. Gardiner. Dated March 21st. (Complete.)

5,393. "Improvements in trolley poles and standards for electric traction." R. P. Strachan. Dated March 21st.

5,394. "An improved method of insulating electrical conductors." E. Nappert. (O. Schaefer, Germany.) Dated March 21st. (Complete.)

5,402. "Improvements in and connected with primary and secondary galvanic cells." E. J. Wade. Dated March 22nd.

5,429. "Improvements in and connected with granulated carbon transmitters." H. Oppenheimer. (Actiengesellschaft, Mix & Genest, Germany.) Dated March 22nd.

5,430. "Cable suspenders for multiple switchboards or similar apparatus." H. Oppenheimer. (Actiengesellschaft, Mix & Genest, Germany.) Dated March 22nd.

5,431. "Improvements in and connected with multiple switchboards for telephone exchanges." H. Oppenheimer. (Aktiengesellschaft Mix & Genest, Germany.) Dated March 22nd.

5,448. "Magnetic chucks." O. S. Walker. Dated March 22nd. (Complete.)

5,482. "Improvements in driving vehicles by electricity." J. Enright. Dated March 23rd.

5,496. "A process for depositing pure tin by electrolysis." E. Quintaine. Dated March 23rd. (Complete.)

5,521. "Improvements in the manufacture of primary batteries." M. Leclanché. Dated March 23rd.

5,528. "Improvements in electric accumulators." L. Gumiel. Dated March 23rd. (Complete.)

5,561. "Transformer of alternating currents into continuous currents of equal or different tension." R. Rouge and G. Faget. Dated March 24th., (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 27th, 1899, being date of application in France.)

5,562. "Improvements in apparatus for transforming single and multiphase alternating currents into continuous currents and inversely." R. Rouge and G. Faget. Dated March 24th. (Date applied for under Patents, &c., Act, 1883, Sec., 103, November 14th, 1899, being date of application in France.)

Mr. Burleigh will not contend reduces the skill and efficiency of the man. We will prove this assertion by a brief account of the Telegraph Battalion of the Royal Engineers. In times of peace this battalion consists of two divisions, as follows:—The first division contains 173 non-commissioned officers and men, including drivers, &c. The latter are not, as a general rule, telegraphists. This division is stationed at Aldershot, and is trained specially in the duties of constructing, maintaining, and working the field lines. The second division is composed of 165 non-commissioned officers and men, of whom every one is employed in some capacity in the Southern Engineering District of the Post Office. About 60 of these men under normal conditions are employed in the larger post offices, such as Bristol, Exeter, Plymouth, Brighton, &c., as telegraph operators sharing the duties and conditions of the civilian operator. Speaking from personal experience, we can confidently aver that there is no distinction between them on the score of efficiency or smartness. The remainder of the second division carry on the engineering duties of the Southern postal district. Nor is it at all to be wondered at that they are of equal proficiency with their civilian colleagues, for it is safe to say that 75 per cent. of the second division are men who have left the Post Office employ to become telegraphists in the Corps of Royal Engineers, and even then have to pass a severe test. If reference is made to form $\frac{\text{P. } 98}{1,621}$, which gives the conditions of "enlistment of telegraphists in the Corps of Royal Engineers," it will be found that in addition to the usual physical conditions, the following qualification is demanded:—

"Proficiency as a telegraphist. To receive and send well on the Sounder not less than 22 words per minute, and to be able to take charge of a moderately busy sounder circuit in a Post Office."

Now, this is precisely the same test which is demanded of a postal telegraphist before he is given charge of a public wire. Evidently the expertness of a military telegraphist and that of the "trained specialist of civil life" are identical.

In times of war the Telegraph Battalion is reinforced by a Telegraph Reserve. The strength of this Telegraph Reserve before the present war was 100. It has now been raised to about 150, and will probably be still further increased. The men forming the Telegraph Reserve are postal operators who are also efficient volunteers. These men are among the pick of the "trained specialists of civil life," and are drawn from the Central Telegraph Office and other large postal centres. They are nominally enlisted into the Royal Engineers, serving one day with the colours, and are then passed directly into the reserve. They are men acquainted with all the latest developments of high-speed telegraphy, and thoroughly versed in the practical work of the profession. It is safe to say that 75 per cent. of the telegraphists employed on the lines of communication in South Africa at present are men of the Telegraph Reserve, and the whole of the Headquarters Staff of Telegraphists are such men. If efficient telegraphing can be done, if the lines are capable of high-speed work, the men now in South Africa who are actually the lauded "trained specialists of civil life" will be able to accomplish it. Fast Wheatstone sets are at work and rapid operators are in charge. So we see that the comparison made by Mr. Burleigh, which is intended to compare the military telegraphist unfavourably with his civilian brethren, is merely a splenetic display of journalistic zeal, which a knowledge of the real facts will not support. The military telegraphists of the Corps of Royal Engineers are practically the "trained specialists of civil life," who, for the nonce, have donned a uniform.

Exactly the same can be said of the railway companies of the corps. Those now employed in South Africa are largely made up of the Railway Reserve, which is almost entirely composed of the employés of the large railway companies, particularly the London and North-Western Railway Company.

Unfortunately for himself, Mr. Burleigh has chosen to attack the Royal Engineers at two points where their organisation and efficiency are greatest, and where their practical value and training are admitted to be of the highest order. In establishing a comparison, he has reduced his charges to mere absurdity, because the two terms of his comparison turn out on examination to be only one. We have endeavoured in this brief recital of facts to defend a valuable arm of our Service from unmerited attack, and to induce the tribunes of journalism to be more discreet in their utterances upon those matters which require a technical knowledge which is not usual among modern newspaper authors.

A recent issue of the *Times* contained the following from one of its correspondents. We quote it as a proof that opinions are divided among war correspondents themselves, as to the value of telegraph work being performed in South Africa:—

> The telegraph staff under Captain Godfrey Faussett has wrestled successfully with a heavy demand upon it. To set up an aerial line or trail an earth wire day after day in advance of headquarters and to keep it in efficient working order in spite of wilful interruptions, or, what is far commoner, the accidental breaks caused by wind, wandering animals, or even, as in a recent case, excessively stupid men, over a hundred miles of veldt, is a great achievement, and one for which thanks are due from correspondents more than from others, especially when they have invariably met with the utmost courtesy and consideration from all therewith connected.

It will be interesting to see whether the *Daily Telegraph* correspondent will adopt a more reasonable and kindly attitude towards the Royal Engineers when he has obtained a closer acquaintance with their work.

Electric Tramways and the Law of Nuisance.

We published in our last issue a report of the case of J. Goldberg & Sons *v.* the Corporation of Liverpool, which was heard in the Court of Appeal on April 3rd. A perusal of that case serves to show that although the tramway authority is much exposed to the risk of actions for nuisance, the power to execute all such works as may be "necessary or expedient" does confer upon the Corporation the right to interfere in some degree with the convenience of the public. It appears that the plaintiffs objected to the erection of a pole and fuse box outside their premises in Liverpool, and sought an order for their removal. This was granted by the Vice-Chancellor of the County Palatine at Lancaster, but the Court of Appeal reversed his decision on the following grounds: (1) That the Corporation in erecting the pole and the fuse box were acting within their statutory powers; (2) that they had exercised those powers *bonâ fide* for the purposes for which they were conferred. In the course of the argument the question arose as to whether the Corporation had any statutory power to commit a nuisance. The effect of the judgment delivered by the Master of the Rolls is that where the doing of any act or the erection of any work is authorised by Act of Parliament the mere doing of that act or the erection of that work is not a nuisance which the Court will restrain by injunction. "But for the Act," said his Lordship, "no doubt the plaintiffs could have maintained an action for nuisance. But the Act authorised a nuisance, and unless the plaintiffs can prove that the powers conferred by the Act have been abused, they have no remedy. . . . . The Court cannot go into the question as to what is the most convenient situation for a pole. If they did that they would have to lay down the tramway themselves." Seeing that the Corporation were in this case permitted to erect posts in such a manner as to occasion annoyance to dwellers by the wayside, it might be thought that all nuisances appurtenant to the supply of electricity will be allowed by law. Such, however, is not the case. It has been decided in many cases that leakage of electricity, vibration, or excessive smoke, are all nuisances in respect of which the public may claim the protection of the Courts, and this although the installation has been erected under so-called statutory powers. To borrow an instance from another class of erection, those who build a smallpox hospital, and who are subsequently sued by neighbours who object to the danger of infection arising therefrom, cannot plead that their right to build such a hospital involves permission to create a nuisance. Nevertheless, every work authorised by the Act can, upon the authority of the present case, be undertaken without risk of an action for nuisance, provided that negligence and *mala fides* are not proved against the defendants.

TRACTION MOTOR SUSPENSIONS.

By ERNEST KILBURN SCOTT, A.M.I.C.E.

Part I.—Motors with Gearing.

When a heavily-loaded tramcar passes an uneven joint in the rail, or meets with a slight obstacle, the wheels rise momentarily, and in falling again, produce a hammering effect on the rails and tyres. This, besides jolting the passengers, tends to reduce the life of the motors by abrading the insulation and breaking the commutator connections, whilst the extra stresses on the gearing and axles are also liable to give trouble by the metal becoming brittle. It was therefore soon seen that the proper suspension of the motors was a matter of supreme importance in electric traction, and that springs, or their equivalent, must be employed to avoid shock to the motor and gearing, as well as to allow a slight yielding of the motor at starting and stopping. Again, in order to ensure the teeth running smoothly, all geared traction motors must be hinged to the axle in some way, and yet, at the same time, so connected with the truck as to permit of slight movements of the motor relatively to the truck.

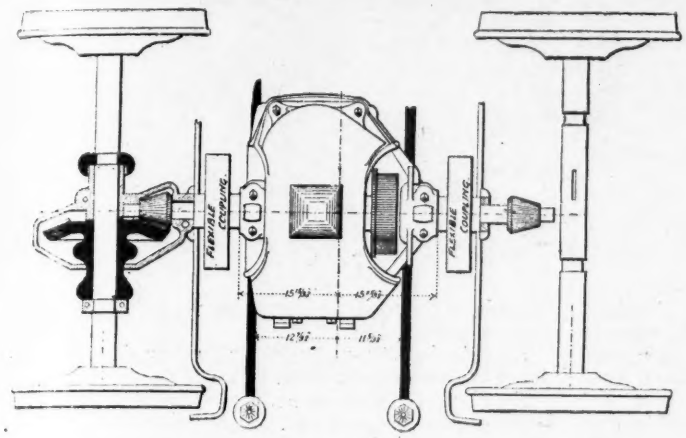

Fig. 1.

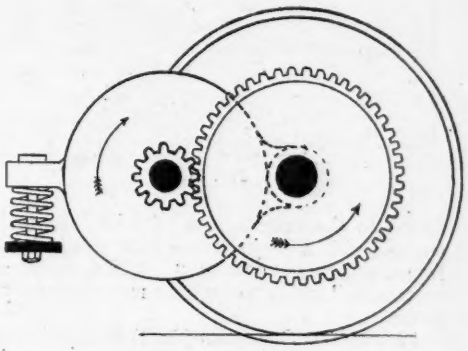

Fig. 2.

An early form of car truck had what may be called the *Sperry Suspension with bevel wheels* (fig. 1). A single motor was fixed parallel with the rails, bevel pinions being fitted at either end of the armature spindle and suitable bevel wheels keyed on the two axles.

The motor was supported from a cross piece fixed rigidly to the truck, the pinions being furnished with short spindles kept in alignment by pedestals swivelled on the main axles. In its normal position the motor spindle coincided with the pinion spindles, and slight displacements in the vertical plane were allowed for by flexible couplings at either end of the armature spindle. It will easily be seen that a worm-wheel drive could be arranged in a similar way.

Wheelbarrow Suspension.—The first motors which were employed with straight teeth gearing had two sets of wheels, and the motor was suspended "wheelbarrow" fashion. Fig. 2 shows the arrangement with single reduction gearing—one end of the motor rests on the axle, and the other end has a casting engaging with springs, which give slightly at starting and stopping, and so allow the motor to move through a small arc of a circle. It will be noticed that the frame enclosing the motor is subjected to an equal and opposite couple to the motor couple applied on the gear

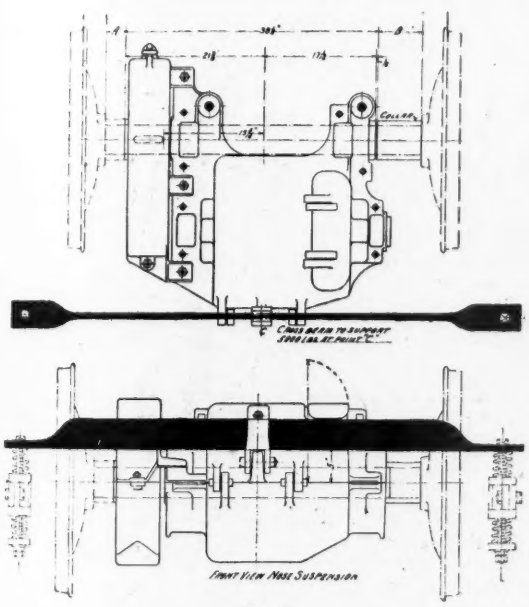

Fig. 3.

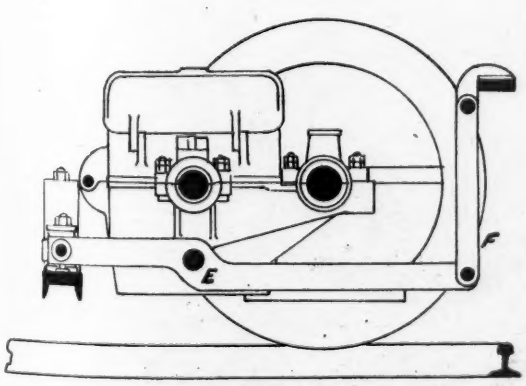

Fig. 4.

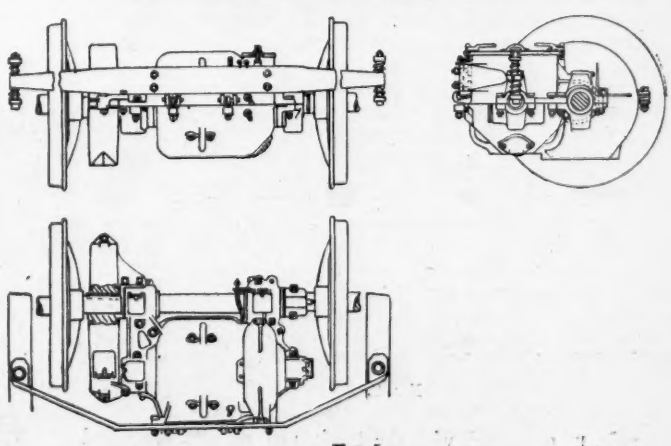

Fig. 5.

which is easily dealt with by a growing demand, and when the electric light industry is half as old as the gas industry now is, it would not be surprising to find that the price at which electrical energy is then supplied would compare very favourably with the present price of gas. I do not suggest that the two industries are really antagonistic; indeed, the contrary would appear to be the case, but a consideration of this point would lead to too wide a digression.

In the current number of *Feilden's Magazine* a table is given, from which at first sight it would appear that oil lamps and gas burners are most expensive as compared with the electric light. It is stated that for the production of 1 C.P. 68 watts are required in a gas burner, 70 in an oil lamp, 2½ to 4½ in an incandescent lamp. Of course the technical man is not misled by this, but the average reader of the magazine would not readily recognise that although an amount of heat proportional to the number of watts quoted no doubt is consumed in the production of 1 C.P. in a gas burner and in an electric lamp, the gas burner does not feed on watts any more than the electric lamp would light up if attached to a gas bracket, and that the matter of expense comes in in the transformation of energy into the requisite form.

Then, again, in most comparisons that the author has seen, a 60-watt lamp is assumed to consume 60 watts and to yield 16 C.P. during its life of 1,000 hours, and similarly a 5-foot gas burner has been assumed to be always of standard efficiency. Further, in speaking of candle-power it has always been assumed that the electric incandescent lamp and the gas burner of ordinary type are strictly comparable as light producers, whereas the ratio of horizontal to mean spherical illumination is greater for the gas flame than for the electric glow lamp, and if by "candle-power" the horizontal candle-power is meant, which is usually the case, the electric glow lamp is placed at a disadvantage in the comparison. Again, variations in the pressure of gas do not injure the burner, whereas variations in the E.M.F. greatly influence the life of an electric lamp. Experiments have shown that the life and efficiency of an electric glow lamp, the current supply for which is drawn from a storage battery, is a very different thing indeed from its life in a house supplied from the mains of a company in which the voltage varies considerably. It is well known that on board some ships electric lamps are found to last a very long time as compared with the average life in electrically-lighted houses, the reason being that in such cases the majority of the lamps are lighted up at the same time and continue alight for long periods, in some cases for the whole voyage. The load being practically constant, there is little difficulty in keeping the voltage constant, and there is comparatively little switching on and off.

Another important matter in connection with electric glow-lamp lighting is the watt efficiency at which the lamps are used. At an efficiency of 4·5 watts per candle from accumulators, an electric lamp may easily last 2,000 hours before it loses 25 per cent. of its original candle-power, whereas if burned at an efficiency of 3 watts per candle, its useful life* would probably sink to less than a quarter of this period. The determination of the economical efficiency at which to run an incandescent electric lamp thus becomes a question of the cost of lamp renewals *versus* saving on the electric light bill. Sometime ago I made a few experiments on over-running some Robertson high efficiency lamps. If a 3-watt per candle 95-volt lamp be placed on a 100-volt circuit, it will be found that the saving in cost of current becomes equal to the price of the lamp after about 95 hours. The experiments were not sufficiently extended or complete to be conclusive as to results, but they were interesting in that they showed that if the cost of electric supply is over 6d. per unit, it would be an economy to use high efficiency lamps and *cæteris paribus* the cheaper lamps become, the more marked is the economy and the lower does the price per unit become at which it is economical to overrun the lamp. These remarks apply to 100-volt lamps. A numerical example will serve to illustrate the degree of economy to be effected. In the experiments above alluded to, a 95-volt 12-C.P. high efficiency lamp (3-watt per candle Robertson) was burned upon a 100-volt circuit. The resistance of the lamp hot was about 264 ohms, and the current which would pass on a 100-volt circuit may be taken as about 0·38 ampere. In these circumstances the initial efficiency may be assumed to be 2½ watts per candle, or the candle-power $\frac{38}{2{\cdot}5}$ = say, 15 C.P. The candle-power, of course, would decrease more rapidly than that of lamps burning at a lower efficiency. It would be fair to assume that the mean consumption of energy during its useful life would be 3 watts per candle. The cost of the lamp was 1s., and taking the price of energy at 6d. per unit, the saving of current by using the lamp at a high efficiency would balance the cost of renewals if the life of the high efficiency lamp be x hours in the following equation:—

$$\frac{x \text{ hours} \times (4{\cdot}5 - 3{\cdot}0) \times 12 \text{ C.P.} \times 6\text{d.}}{1{,}000 \text{ watt-hours}} = 12\text{d.} - y, \quad (1)$$

where 4·5 is the watt efficiency assumed per candle for a lamp of 1,000 hours useful life, and y is the proportion of the cost of the renewal of the 4·5-watt per candle lamp for the life, x, of the high efficiency lamp. We therefore have, as the proportion to be deducted for renewals which would be incurred if the low efficiency lamp were in use :—

$$y = \frac{12}{\frac{1{,}000}{x}} \text{ or } y = \frac{12\,x}{1{,}000}. \quad (2)$$

Resolving, we get

$$108\,x + 12\,x = 12{,}000, \text{ or}$$
$$x = 100 \text{ hours.}$$

Thus if the high-efficiency lamp have a useful life of only 100 hours, it will pay for the extra renewals as compared with the low-efficiency lamp. Should the high-efficiency lamp last 200 hours, which is not a very extravagant assumption, the net saving would be approximately

$$\frac{12 \times 1{\cdot}5 \times 100}{1{,}000} \times 6\text{d.}$$

or nearly 11d. after paying for extra lamp renewals, as compared with the low-efficiency lamp, and the total cost of $200 \times 12 = 2{,}400$ candle-hours, including the price of the lamp, would be

$$\frac{2{,}400 \times 3}{1{,}000} \times 6\text{d.} + 12\text{d.} = 4\text{s. } 7\text{d.}$$

or $\frac{55\text{d.}}{24}$ = nearly 23d. per 1,000 candle-hours, as against

$$\frac{2{,}400 \times 4{\cdot}5}{1{,}000} \times 6\text{d.} + 3{\cdot}4\text{d.} = \text{nearly } 5\text{s. } 8\text{d.},$$

or $\frac{68}{24}$ = 28·3d. per 1,000 candle-hours, including the proportion (3·4d.) to be added for renewal.

(*To be continued.*)

* By useful life is meant the period which elapses before the candle-power is diminished by 25 per cent.

SOME ELECTRIC LIGHTING FIGURES.

HAVING regard to the progress that has been made in electric lighting during the past few years, it is not uninteresting to examine the results that have been achieved in the case of a few London companies, and of two provincial electric lighting concerns. For the purpose of this article it is unnecessary to refer to what has been accomplished by municipalities, the idea being rather to look at the commercial side of electric lighting, or rather from the dividend standpoint, this being impossible with municipal accounts. Half a dozen London companies have been selected for the purpose of these figures, and it is probably unnecessary to give more, because the list is fairly comprehensive as regards different districts. From a shareholder's point of view, any figures relating to the City of London Electric Lighting Company are in the present stage of the company's affairs somewhat melancholy reading. Taking the results of the last three years the net profit has fallen from £87,000 in the year 1897 to something over £60,000 in 1899. 1898 also witnessed a considerable drop in the profits, the sum realised then being £77,000. The dividend has naturally suffered in similar proportion, the excellent dividends of 1897 of 10 per cent. having fallen to the somewhat moderate one of 4 per cent. The capital expenditure has increased from £1,300,000 in 1897 to £1,500,000 in 1899. The lamp

connection has increased very largely, the figures three years ago being 296,000 against 429,000 in 1899. There is no doubt that the small dividend of last year was partly to be accounted for by the considerable reductions in the price of electricity which were made by the City Company in face of the expected competition with the Charing Cross and Strand Company; but though the City Company may deserve a certain amount of sympathy on account of the peculiar and somewhat arbitrary clauses in their provisional order, which compels the allocation of large sums to the reserve fund, it is clear that the large dividend of 1897 could not have been paid if high charges for electricity had not been maintained. For the purpose of comparison we have ventured to apply another set of figures to the operations of the company, namely, units sold per £ of capital expended. Objection may be raised to these on the grounds that they take no account of the large increased expenditure which has not arrived at a profit-earning stage. The answer to this is, if a company is carrying on its business and developing it on proper lines there will always be a certain amount of capital expenditure which at the time of issue of any balance-sheet could not be shown to be earning profits. Unfortunately, the figures of the City Company are not sufficiently complete to enable us to apply this test to the three years' operations; but neither as regards lamps connected, nor units sold, do they compare at all favourably with any company in London. With one exception they sell the fewest units per £ of capital expended of any company in London, and the lamp connection per £10 of capital expended is the lowest without exception. In 1897 the lamps connected per £10 was 2 2, yet it was the best dividend-earning year the company had experienced. The Metropolitan Company has gradually increased its capital expenditure from £850,000 in 1897 to £1,224,000 in 1899. Its net profit fell off somewhat in 1898, but the net profit for 1899 shows a material increase. It is well known that the Metropolitan Company has suffered in a marked degree from what we may term non-profit-earning capital, which has been invested in the form of large works at Willesden that have only been recently put on the circuits. Yet in spite of this the units sold per £ of capital expended does not show so marked a falling off in 1898 as one might have expected. The numbers sold in 1898 were 6·8, the figure being 6·6 last year. The causes we have already mentioned demonstrate why the lamps connected per £10 capital expended show a falling off. Probably the most interesting figures of any of the supply companies are those of the Westminster and St. James's and Pall Mall Lighting Companies, and yet there is a considerable difference in the way they earn their money. The Westminster Company has not paid less than 12 per cent. since 1897, and last year it paid 13 per cent., while the St. James's Company has maintained a steady 14 per cent. for the three years. The increased capital has not been exceptionally heavy though the Westminster Company's capital expenditure is more than twice that of St. James's, and it had very nearly three times as many lamps as the St. James's Company; yet it only supplies 50 per cent. more current.

A study of the figures at once shows how favourable the position of the St. James's Company is, compared to others in regard to the consumption of electricity per lamp. Applying the new figures we have tabulated, the St. James's Company sell 13 units per £ of capital expended; while the Westminster Company sells only nine. Yet the former has only five lamps connected per £10 of capital expended, and the Westminster Company has six, which demonstrates in a striking manner that the St. James's Company have a much better class of consumers. The Kensington and Knightsbridge Company, like the Notting Hill, shows a steady increase all round, and it pays 1 per cent. more in the dividend than in 1898; it has increased its capital

SUPPLY COMPANIES

	Capital expenditure.			Net profit.			Dividend.			Allocated to reserve or depreciation account.		
	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.
	£	£	£	£	£	£	%	%	%	£	£	£
City of London Electric Lighting Company ...	1,513,456	1,374,669	1,318,574	60,600	77,767	87,022	4	6	10	23,000	20,000	22,000
Metropolitan Electric Supply Company	1,244,000	993,000	850,000	53,000	40,000	43,000	5	5	6	13,000	13,000	15,000
Westminster Electric Supply Corporation ...	683,568	626,365	560,388	* 34,668	* 28,033	...	13	12	12	21,000	18,426	...
St. James's and Pall Mall	317,283	263,046	231,895	31,834	29,890	30,921	14½	14½	14½	12,000	10,517	9,269
Kensington and Knightsbridge Company ...	273,813	163,481	252,162	19,201	...	7,263	11	10	10	4,000	5,408	8,061
Notting Hill Electric Light Company	137,350	128,003	113,184	10,360	7,251	3,884	7	6	6	1,550	875	1,000
Hove Provincial Electric Lighting Company ...	93,660	77,450	66,896	7,097	5,089	3,602	7½	6½	5	2,000	1,000	...
National Electric Supply Company (Preston) ...	93,350	77,960	70,200	...	...	...	9 6	6 9	..	1,648	1,123	...

* After allocating depreciation.

	No. of units sold.			Lamps connected.			Units sold per £ of capital expended.			Lamps connected per £10 of capital expended.		
	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.	1899.	1898.	1897.
City of London Company	...	6,895,667	...	429,628	355,825	296,012	...	5 01	...	...	2·6	2·2
Metropolitan Electric Supply Company	8,300,000	6,800,000	...	500,000	430,000	360,000	6·6	6·8	...	4	4·2	4·2
Westminster Electric Supply ...	6,329,554	5,065,195	4,355,781	421,445	339,986	290,561	9·2	8	7·7	6·2	5·4	5·5
St. James' and Pall Mall	4,201,104	3,448,858	3,028,242	164,750	142,853	126,827	13·2	13·1	13·1	5·2	5·4	5·4
Kensington and Knightsbridge ..	2,463,950	2,081,074	1,898,362	183,462	156,158	137,955	9	7·5	7·5	6·7	5·8	5·0
Notting Hill Electric Supply Company...	665,129	455,871	354,969	59,154	46,066	33,000	4·3	3·5	3·1	4·3	4·0	2·9
PROVINCIAL.												
Hove Electric Light Company ...	444,499	350,254	263,243	44,892	36,967	27,777	4·7	4·7	4·0	4·7	4·7	4·1
National Electric Supply Company (Preston)	601,519	448,037	371,301	40,102	30,850	...	6·4	5·7	5·3	4·2	3·6	...

expenditure by £10,000, and it has contrived to bring up the units sold per £ of capital expended from 7·5 to 9. It has also increased somewhat the lamps connected per £10 of capital expended. The Notting Hill Company probably shows better than any concern in London the vitality of the electric lighting business; for when this company started, many pessimists urged that it would never show much in the way of profit. Yet after a steady dividend of 6 per cent. it has been able to declare 7 per cent. for 1899, although the number of units sold per £ of capital expended are far and away the lowest of any company in London; the figures being 4·8, which compares very unfavourably with the 13·2 of the St. James's and Pall Mall Company.

The figures of the Hove and the National Electric Light Companies are interesting, in so far that they show there is no very striking difference between the electric lighting business of the metropolis and the provinces. There is, however, a curious closeness in the capital expenditure of the two provincial companies we have selected, but the northern company shows considerable advantage in the units sold per £ of capital expended.

THE CONSTRUCTION OF OVERHEAD EQUIPMENTS.

(*Continued from page* 431.)*

IV.

The breaking stress of ordinary annealed iron wire is 25 tons per square inch of cross-section. Bessemer steel wire breaks at 40 tons, mild Siemens-Martin steel at 60, improved ditto at 80, while crucible steel and improved ditto break as high as 100 and 120 tons per square inch. The choice of material and of strength is thus very wide. The higher price of the stronger wire would justify less of it being used, but, if the waste due to corrosion is great, the wire must be larger, and it is false economy to use a span wire both expensive and thick when a cheaper grade will have already a large margin of strength.

In the ordinary way span wires are only exposed to the load of the trolley wires. They are not called on to bear any stress in the direction of the length of the trolley wire, for this is all dealt with, or should be, by special anchor wires. The latter consist of steel stranded ropes, similar to the span wires, that are extended from special anchoring ears at a span wire to the next pair of poles away from the direction of stress. Such anchorages are needed at the top of gradients to carry the down-pull, which may be considerable.

On a hill of 400 yards there are 10 trolley spans of 40 yards each of 90 lbs. weight, or a total of 900 lbs. On a gradient of 1 in 20, this is equivalent to a pull down hill of $\frac{900}{20} = 45$ lbs. to be provided for by anchor wires. Termini also require to be anchored, the end of a line being usually provided with a specially heavy anchor pole.

Span wires and anchor wires are attached to poles by wrought-iron straps, as in fig. 19, slipped over the pole top and clipped by bolts, one of which holds the strap firmly to the pole, and the other serves as the pin for the wire attachment. Trolley wires are attached to span wires by specially insulated hangers, and there are insulated tightening bolts, technically known as *strains*, between the span wire and the pole. The trolley wire is thus doubly insulated from the poles.

* Erratum.—By a slip in fig. 16, page 431, the distances y_1 and y_2 were wrongly shown. They should have been as under, or the distance from point of suspension to the lowest point of the wire. Fig. 15 for the Catenary is correctly drawn.

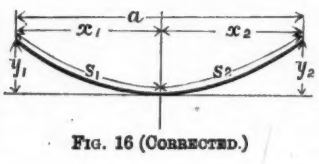

Fig. 16 (Corrected.)

The hanger consists of a bolt which is fixed to a gun-metal casting by means of a moulded piece of insulating material. The casting carries two lugs which hook upon the span wire, and the span wire loops round the wide part of the casting, and is thus firmly held. A special tool is used to attach the castings to the taut wire. To the insulated

Fig. 19.

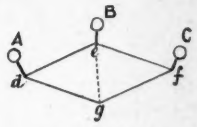

Fig. 20.

bolt is screwed a long grooved ear of gun-metal. This is a semi-circular-grooved bar into which the trolley wire is soldered. Its length is usually 15 inches. All trolley-wire attachments are made with various forms of these ears. Some are plain, for attachment simply to the plain hanger, others have special holes and lugs to serve as splices to join lengths of trolley wire together; other ears again have holes for attaching feeder wires whilst plain ears are used for holding pull-offs. These are special attachments for the holding of pull-off wires, for the purpose of pulling a length of straight trolley wire laterally to an angle or to a polygonal form so as to sufficiently approximate to the form of the curve of the rails below. At every such attachment to the trolley wire and to poles insulators are inserted. The usual form is a globe of insulating compound moulded over two interlocked eyes which are kept apart by the material. Failure of the material simply allows the two eyes to come together; no breakage of the line occurs, though, of course, the insulation fails. Before a trolley wire can be earthed there must be a failure of the two insulators interposed between it and the pole.

Trolley wire is only put up in continuous lengths of about 880 yards. At each such length or section, a section insulator is placed between the two lengths of wire. These insulators resemble a long ear, of which the middle is formed of bars of wood. At these insulators each trolley section is supplied with current by feeder cables. In putting up trolley wire the drum on which it is wound is mounted on a dray or special reel waggon fitted with a brake to check the rotation of the reel. One end of the wire is anchored to the poles next beyond the section insulator, and the reel waggon is drawn forward by a horse at a slow speed, the wire being kept sufficiently taut not to hang in loops too near the ground. Behind the reel waggon the tower waggon follows at about 40 yards, and as each span wire is passed the trolley wire is hung freely to it by means of little S hooks. When half-a-mile has thus been reeled out, it is seized by what is known technically as a *come-along* clamp, which holds the wire firmly, and can itself be hooked to a set of three sheave blocks by which the wire is drawn up tight and temporarily anchored.

In order to take the stress off the section insulator the suspension ears at the span wires next to the insulator, *i.e.*, at the next pole, are made anchoring ears, and anchor wires extend from these to the section poles. These section poles are thus anchor poles and should be somewhat stiffer than ordinary poles. It is, of course, necessary to interpose two insulators in the course of each anchor wire in order to place their insulation on a par with that of the span wires. The section poles, as already said, are also feeder poles, and serve to carry the four feeder cables that connect to the four trolley wires attached to the two section insulators.

The feeder cables are carried up the interior of the feeder pole; only one pole is used for the purpose, the cable track being on one side only of the road. These feeder cables are taken into the pole from the feeder box, usually placed about 4 feet away from the pole. They enter by holes or slots, and emerge in similar manner through holes near the top of the pole, whence they are carried along the span wire to the section insulator. The feeder box is fitted with switches by means of which each feeder cable can be cut out, and a length of trolley wire may thus be made dead by opening its feeder switches in the boxes at each end of the section. The main feeder cables are also brought up into each box to suitable switch terminals, and can be switched out at will.

The span wire system of suspension, now briefly described, is the best for running purposes, possessing great elasticity

and permitting the easy running of the trolley wheel without shock or sparking. It is also the least obstructive in the streets, and much to be preferred on all accounts to the side bracket system, which cannot be carried out without the use of sometimes excessively long bracket arms, and often even these cannot be used, but span wire poles must be employed.

In the bracket arm system the arms consist of very stout steel tubes nominally 2 inches diameter internally, but actually about 1⅞ inches. They are screwed into cast-iron clamps and then are clamped upon the poles. The arms are supported by one or two tension rods extending from the arm at various distances to a point nearer the pole top than the arm clamp. Below the arm the angle between pole and arm is filled with light wrought-iron scroll work. This is supposed to be beautiful and has a singular attraction for mayors and aldermen. It is only when brackets are short, double, and upon poles placed along the centre of a road that they have any good appearance. They are then about 5 feet long, and this projection is fairly proportionate to the length of pole and free from the bad effect of long bracket arms. Poles with brackets require to be raked very much, as when they carry span wires; the weight of the bracket arm and the 90 lbs. of wire and hangers hung upon it having considerable effect in pulling over the pole top. Round curves, where the poles are on the concave or outer side, the pull of the curve adds itself to that of the load and increases the necessary rake back on the poles, but when on the convex or inner side of the curve the wire tension helps to counteract the weight of the bracket arms.

For constructive purposes, and especially the attachment of pull-off wires, the outside position should always be chosen if possible despite the greater stress upon the poles. Indeed, when placed on the inside of curves of small radius the curve can only be worked round by using a wasteful number of poles set close together, whereas with the poles on the outer side the curve can be pulled off very neatly by wires from the adjacent poles. The pull-over stress on a pole due to the curvature of the wire may thus be calculated graphically:—In fig. 20 let A, B and C be three poles upon a curve. The stress upon pole B is to be obtained by laying out the wire to scale in its correct position, *d e f*, and completing the parallelogram, *d e f g*. Then to the same scale that *d e* represents the tension in the trolley wire, so will *e g*, the diagonal of the parallelogram, represent the lateral pull on the pole. So, too, with the vertical load of the trolley wire. In fig. 21 let W be this load, let

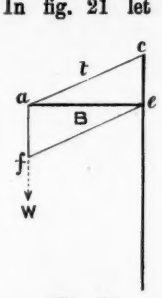

Fig. 21.

t be the tie rod, and B the bracket arm. Complete the parallelogram *a c e f*. Then if *a f* = 90 lbs. so *a c* to the same scale will be the pull on the tie rod *t*, and *a e* will be the thrust along the arm. The effective lateral pull upon the pole as a whole is as the ratio of the arm length and the distance from the ground to the bracket arm. Thus if an arm be 5 feet long and 20 feet above the ground the pull on the pole will be $\frac{90 \text{ lbs.} \times 20}{5} = 360$ lbs. Long bracket arms are thus, apart from their own weight, which may be similarly calculated, fully as severe on poles as span wire stresses. An ordinary bracket arm alone without any scroll work weighs about 5½ lbs. per foot. A 20-foot arm thus represents a weight of 110 lbs. acting at a lever arm of 10 feet, or 55 lbs. at the end of the arm in addition to the 90 lbs. of trolley wire. This total of 145 lbs. includes nothing for scroll work, which will probably bring up the total to nearly 200 lbs. at 20 feet leverage. No reliance is to be placed upon the grip of the arm clamp to the pole or of the pole in its concrete bed, but anchorage must be provided against all longitudinal pull on the trolley wire. It may frequently happen that a direct terminal anchorage cannot be had, and the anchor wire must be taken singly and diagonally to the next side pole in exactly the same way as double anchors are taken to both span poles. An anchor has thus a resultant pull upon the anchor pole inwards to the street and of the pole at the anchor ear outwards from the street. So far as possible these various pulls are taken into account in raking the poles and choosing their strengths.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1900.

Compiled expressly for this journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

5,146. "Improvements in or connected with fittings for electric lighting." F. Shaw and F. Greenfield. Dated March 19th.

5,154. "Improvements in electric traction." S. G. Bennett. Dated March 19th.

5,167 "Improvements in and relating to alternating current electro-motors," J. Yates, W. Yates, and J. B. Bent. Dated March 19th. (Complete.)

5,178. "Improved means for connecting electric cables." C. A. Day. (J. G. White, United States.) Dated March 19th. (Complete.)

5,183. "Improvements in electric locks." H. E. Newton. (H. G. Carleton, United States.) Dated March 19th. (Complete.)

5,184. "Improvements relating to electric tramways." F. B. Aspinall and A. J. Ireland. Dated March 19th.

5,187. "An automatic telephone-call recorder." A. E. Lamkin. Dated March 19th.

5,191. "Improvements in electric heating systems for cars." The Westinghouse Brake Company, Limited. (F. C. Newell, United States.) Dated March 19th.

5,196. "Improvements in simultaneous electric telegraphy and telephony." C. Adams-Randall. Dated March 19th.

5,216. "Improved manufacture of filaments for electric incandescent lamps." A. J. Boult. (A. Blondel, France.) Dated March 19th. (Complete.)

5,221. "Improvements in the distribution and collection of current for electric traction." G. Davis. Dated March 19th.

5,232. "Improvements in storage batteries." P. Kennedy. Dated March 20th. (Complete.)

5,252. "Improvements in apparatus for controlling and regulating electric motors." L. Higginbottom, J. H. Hindle, and T. Mannock. Dated March 20th.

5,257. "Improvements in apparatus for winding or producing coils, bobbins, helices or the like, such as are used for electrical purposes." W. G. Heys. (J. Scott, R. Varley, and J. C. Anderson, United States.) Dated March 20th. (Complete.)

5,274. "An improved process of and apparatus for the electro-deposition of metals." W. Y. Buck. Dated March 20th. (Complete.)

5,293. "Improvements in or connected with lead presses for making plates for electric accumulators and the like." W. P. Thompson. (Accumulatoren and Electricitäts Werke Act. Ges., vorm W. A Boese & Co., Germany.) Dated March 20th. (Complete.)

5,294. "Improvements in electric bells." W. R. Wynne. Dated March 20th.

5,321. "Improvements in plates for storage batteries." H. J. Haddan. (C. A. Lindstrom, J. Hewitt, and T. Hewitt, United States.) Dated March 20th. (Complete.)

5,327. "Improved system of distribution and collection of current for electric traction." G. Davis. Dated March 21st.

5,353. "Improvements in electric traction." E. H. Tyler. Dated March 21st.

5,356. "Improvements in or relating to electric cables." R. K. Gray. Dated March 21st.

5,361. "An improvement in lamp caps for bayonet socket electric lamp-holders." E. G. Sheppard and Nernst Electric Light, Limited. Dated March 21st.

5,376. "Improvements in electrodes for electrolytic purposes." E. Hopkinson and A. T. Smith, Jun. Dated March 21st.

5,387. "Improvements in apparatus for wireless telegraphy." G. Marconi. Dated March 21st.

5,389. "Improvements in and connected with electrically operated railway signals." J. Shoecraft and C. C. Gardiner. Dated March 21st. (Complete.)

5,393. "Improvements in trolley poles and standards for electric traction." R. P. Strachan. Dated March 21st.

5,394. "An improved method of insulating electrical conductors." E. Nappert. (O. Schaefer, Germany.) Dated March 21st. (Complete.)

5,402. "Improvements in and connected with primary and secondary galvanic cells." E. J. Wade. Dated March 22nd.

5,429. "Improvements in and connected with granulated carbon transmitters." H. Oppenheimer. (Actiengesellschaft, Mix & Genest, Germany.) Dated March 22nd.

5,430. "Cable suspenders for multiple switchboards or similar apparatus." H. Oppenheimer. (Actiengesellschaft, Mix & Genest, Germany.) Dated March 22nd.

5,431. "Improvements in and connected with multiple switchboards for telephone exchanges." H. Oppenheimer. (Aktiengesellschaft Mix & Genest, Germany.) Dated March 22nd.

5,448. "Magnetic chucks." O. S. Walker. Dated March 22nd. (Complete.)

5,482. "Improvements in driving vehicles by electricity." J. Enright. Dated March 23rd.

5,496. "A process for depositing pure tin by electrolysis." E. Quintaine. Dated March 23rd. (Complete.)

5,521. "Improvements in the manufacture of primary batteries." M. Leclanché. Dated March 23rd.

5,528. "Improvements in electric accumulators." L. Gumiel. Dated March 23rd. (Complete.)

5,561. "Transformer of alternating currents into continuous currents of equal or different tension." R. Rouge and G. Faget. Dated March 24th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 27th, 1899, being date of application in France.)

5,562. "Improvements in apparatus for transforming single and multiphase alternating currents into continuous currents and inversely." R. Rouge and G. Faget. Dated March 24th. (Date applied for under Patents, &c., Act, 1883, Sec., 103, November 14th, 1899, being date of application in France.)

5,569. "Improvements in or connected with electric storage batteries." W. P. Thompson. (E. A. Sperry, United States.) Dated March 24th. (Complete.)

5,585. "Improvements relating to the measurement of electric power and energy in three-phase alternating current systems." R. Arno. Dated March 24th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 26th, 1899, being date of application in Italy.)

5,593. "Improvements in electricity meters." A. Wright and The Reason Manufacturing Company, Limited. Dated March 24th.

ELECTRICAL PATENTS OF 1886 EXPIRING IN APRIL, 1900.

We are informed by W. P. Thompson & Co. that about 100 applications for electrical patents were filed in April, 1886, of these some were never completed, and of those that were, only one has been maintained to run its full length of term, viz., 14 years, and being of considerable interest we give a short abstract of it below:—

5,168. "Improvements connected with the electric lighting of trains." R. E. B. Crompton and J. Swinburne. Dated April 14th, 1886. Relates to dynamos for lighting railway trains. The dynamo is driven from the axle of the carriage through a countershaft, and is in connection with secondary cells. The field magnets are wound with two wires as if the dynamo were an ordinary shunt machine working at about 500 revolutions. The lamps are in shunt to the armature, but the cells are so connected up with the second wire that if the dynamo charges them the current traverses this wire and demagnetises the field magnets. If, therefore, the speed increases above 500 revolutions the dynamo charges the cells, but the pressure on the lamps does not increase. If the speed falls below 500 revolutions the cells supply part of the current to the lamps, and in doing so magnetise the field more strongly. When the speed falls below a certain number of revolutions a cut-out breaks the armature connections. To allow the dynamo to reverse with the train, the tangent brush carrier is mounted on the axle so as to turn with it until adjustable stops hold the brushes in the right position for the direction of rotation. 3 claims.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1897.

15,721. "Improvements in electric arc clamps." R. Haddan. Dated July 1st, 1897. Relates to arc lamps. Curved carbons are carried by holders in a supporting frame. Each holder consists of a radial arm, and a quadrantal or semi-circular rod to the free end of which the carbon is attached, the rod being bent laterally so that the carbons are in one plane. Near the carbons, the holders are engaged frictionally by insulated spring-pushed rollers, or bent springs, on arms of the core of a series solenoid, by which an arc is struck and maintained, the carbons feeding forward by gravity. One holder is insulated, and provided with a flexible conductor. A screw limits the upward motion of the core. A reflector is supported over the arc. 1 claim.

30,470. "An improved electricity meter shelf fixing or box and a main connection board or box combined." F. W. E. Jones. Dated December 24th, 1897. A supply meter, a maximum demand indicator, fuses, and a main switch for a house service, are mounted in a case. This is preferably of cast-iron, with a removable sliding top and a hinged front. The front is provided with a lock, and a cord may be passed through holes in the front and one side of the case and sealed. Windows in the front permit the meter dials and fuses to be seen. The front may be in two parts. The switch handle projects through a slot in the case. The case is provided with lugs to carry a wooden shelf for the meter, and with bosses through which fixing screws are passed. It may also have feet and handles. 4 claims.

30,494. "Improvements in the armatures of induction motors." W. L. Wise. (Maschinenfabrik Oberitikon). Dated December 24th, 1897. The armature or secondary element of an induction motor is wound with groups of short circuited coils composed of bare wire laid in groove or holes of the iron body. One form is of a drum winding consisting of a number of groups of bare wire coils, each of which is short circuited at a certain point. 2 claims.

30,544. "Improvements relating to the electric welding of tubes and to apparatus therefor." O. Parpart. Dated December 24th, 1897. Relates to apparatus for welding longitudinal joints of tubes such as bicycle tubes. The poles of a transformer are connected with the standards which are insulated from the frame of the machine and carry supports for the copper discs which revolve in contact with the tube on opposite sides of the joint. The inclination of the discs can be adjusted as well as their position. A little in front of the discs are placed the pressure rolls which complete the welding. They are insulated from the standards and are driven by suitable gearing. Fore and aft of the welding apparatus are situated pairs of draught rolls which feed the tubes forward. A guide is placed before the first pair of feed rolls, and a second guide between them and the welding apparatus to ensure the joint of the tube being upwards. Additional rolls on the delivery side of the machine keep the tube straight. For welding taper tubes, special rolls of snail-cam section are employed. 16 claims.

30,572. "Improvements in joints for electricity conductors." C. C. Fowler and The Mutual Electric Electric Trust, Limited. Dated December 28th, 1897. Branches taken off armoured cables have the joint protected by means of a two-part metal frame or case. The two parts, when in position, are joined together, &c., to the armouring by wiping or other suitable solder joint. The case is then preferably filled with oil through a suitable orifice, which is finally hermetically closed. 4 claims.

30,622. "A combined manual and automatic switch for electric circuits." R. L. Hailey. Dated December 28th, 1897. Relates to a combined manual switch and magnetic cut-out, so arranged that the switch is opened should the current excited exceed a predetermined limit. One arrangement is shown in which the switch arm is pivoted and is fitted with an arm adapted to force down a piston against a spring. The piston is locked by a latch. A solenoid having a core is included in the circuit. When the current is excessive, the core is raised, its end striking the lever of the latch and so freeing the piston, which is forced upwards by the spring and so throws over the switch. 4 claims.

30,626. "Improvements in the method of, and means for, regulating the phase relation between current and electromotive force in alternating current systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. P. Steinmetz and E. Rice, jun.) Dated December 28th, 1897. Regulating or controlling the phase relationship between current and electromotive force. A closed secondary conductor is rotated relatively to its primary at a rate above or below synchronism, according as an advance or retardation of the current is desired. The self-induction of this member should be variable. One arrangement is described in which the electro-dynamic controller with the induced member having a high self-induction relatively to the inducing member. The self-induction is varied by coils. The member is preferably driven at a higher speed than synchronism by the motor other motor. 3 claims.

30,627. "Improvements in and relating to electric railways." The British Thomson-Houston Company, Limited. (W. B. Potter.) Dated December 28th, 1897. Relates to electric railways on the third rail system, having sectional conductors substituted for the third rail at stations, crossings, &c. One form is described of a plan at a station with two series of sectional conductors. A shunt current from a second brush on the vehicle passes through one series of conductors to the magnet coils and throws the switch. If the circuit to this brush is broken on the vehicle, the switch will be de-energised and the main current lost. Any switch may be excited from the signal cabin when necessary to start the train. The switches may be mechanically locked in their open or closed position for stopping the train or for allowing it to run through. 7 claims.

30,628. "Improvements in induction watt-hour meters." The British Thomson-Houston Company, Limited. (E. Thomson and W. H. Pratt.) Dated December 28th, 1897. Induction motor meters for alternating currents, available for non-inductive or inductive loads, and adjustable for any ordinary frequency. A hollow cylindrical armature carried by a vertical spindle rotates in the spaces between a stationary magnet and a frame, both of laminated iron. The magnet is wound with fine wire coils connected in series with a separate inductance coil between the mains. The frame has two polar extensions near the magnet, and two others which are magnetised oppositely by coils carrying the main current. The frame also carries coils which are connected in a closed series, and retard the magnetisation of the shunt magnet to exactly 90° from the phase of the main electromotive force. In the construction of the meter, the iron parts are screwed to projections on a bracket attached to a metal back plate. The vertical spindle is carried between jewelled bearings on screws on this and an upper bracket, and gears with a counter on the upper bracket. It carries a conducting disc within two permanent brake magnets supported by the upper bracket. This also carries the inductance coil. Four terminal plates are provided on a board attached to the back plate below the lower bracket. Inductive resistances.—The inductance used in the meter is a coil wound in the middle of a core. This is placed within a frame which forms magnetic circuits closed except for small air gaps. The core and frame are screwed to a non-magnetic plate. Small misplacement of the core in the frame does not affect the total air gap. The coil is connected at several points with the studs of a switch, by which portions of it may be cut out of the potential circuit of the meter. This enables the meter to be used with currents of various frequencies, while the air gaps render the readings of the meter correct throughout its range. 8 claims.

30,678. "A new or improved method of re-transmitting telegraphic messages and apparatus for use in connection with the said method, and for other purposes." J. Rymer-Jones. Dated December 28th, 1897. Translators for automatic working are so arranged so that, at the intermediate station, the message is reproduced by an electro-magnetic perforator, and is re-transmitted on to the second cable. The two cables are connected to a rotating commutator arranged with four brushes so that either cable can be connected to a relay or to a transmitter. The relay is preferably of the form described in Specification No. 5,040, A.D., 1897, and is provided with additional contacts, operated by slow reversals, for releasing the clockwork of the commutator when it is desired to reverse the connections. The perforator may have the tape carried by the armature of two opposing magnets so that it is brought against either of two rotating cutters. The paper is either fed step by step, or continuously with the punches, whether still or rotating, forced through the paper. The paper passes over the punching table after it leaves the feed rollers, and before it reaches the yielding rollers, so that any slack can be taken up. As a terminal preparing instrument, a triple key may be employed for operating the punches. 7 claims.

30,719. "A machine for surfacing and polishing rolls, particularly the rolls of rolling mills, worked by an electric motor." K. Breitenbach and F. Breitenbach. Dated December 29th, 1897. Grinding wheels are secured upon the ends of the spindle of an electric motor, which is supported by means of a bar, provided at its ends with pivots fitted in bearings. These are carried by a table adjustable angularly on a slide by means of hand wheels. The slide is movable along a bed by means of a hand wheel, bevel gearing, and rack and pinion. The bed is adjustable upon supporting rails fixed to the inner sides of the roll standards. The motor and wheels are adjustable vertically by means of a projecting arm, hand-wheel and screw. In a modification the spindle of the wheels is at right angles to that of the motor, and is driven by bevel gearing. 3 claims.

30,832. "Improved arc lamp carrier." J. Brookie. Dated December 30th, 1897. An arc lamp is supported on a post or the like by an insulated bolt in a cylinder which is carried by one or more arms on a socket fitted to the post. The globe is attached to a ring sliding on the cylinder, so that it may be raised and held up by a hook during trimming. Normally the globe rests on a cup carried on the socket. This cup contains fixed terminals, to which the lamp is connected. The arms also support a dome. 1 claim.

30,846. "A method or methods for controlling a mechanism or mechanisms by means of electric or electro-magnetic waves of high frequency." E. Wilson and C. J. Evans. Dated December 30th, 1897. Relates to means for controlling mechanism from a distance by means of electric or electro-magnetic waves, known as Hertzian, without the intervention of a metallic conductor. The object is to obtain a selective effect, that is, that two or more circuits controlling electro-magnetic mechanism may be separately controlled from or by the transmitter. The receivers are arranged at right angles. The transmitter has a pair of conductors carried by a rotary disc suitably supported. When the conductors are vertical one receiver is affected, and when horizontal the other receiver. In a modified transmitter two pairs of fixed conductors are arranged at right angles. Instead of having two receivers, one only may be employed, and this may be successively connected to the various circuits to be controlled by clockwork or other mechanism. A receiver is shown in which the coherer is replaced by a core of steel wires wound with a coil. A magnetic needle is suspended near the core, and when the core is magnetised rests with a conductor against a stop. When the core is demagnetised by the electric waves, the needle is deflected and closes a circuit, the core being again magnetised. A mirror may be affixed to the magnet. In other forms mercury globules may be arranged for making the contact under the influence of the electric waves. Movable receivers, &c., may be supported and connected with electro-magnetic or other devices to maintain them in the desired plane, and they may be arranged in gimbals to keep them horizontal. The provisional specification states that the invention is applicable for controlling torpedoes, air ships, search lights, guns, &c. In the case of a torpedo, the electro-magnetic mechanism may control the rudders, engines, position of the centre of gravity, &c. 5 claims.

30,848. "Operating railway points by electromotors." J. A. Timmis. Dated December 31st, 1897. The points are operated by the electromotor, the motion of which is transmitted through the worm to a screwed sleeve, &c., the sleeve having stops engaging the elbow-lever which is adjustably connected to the points rod. The lever is normally locked by the weighted lever. In operation, the first movement of the sleeve causes the incline cam to disengage the lever and the further movement of the sleeve operates the points, after which the lever returns and locks the points in their altered position. The operation of the motor is controlled by a lever in the cabin. Points detectors may also be provided to control the signal circuits, so that a signal cannot be lowered until the points are properly set. In a modification, the points are locked by a separate bolt, which is controlled by an ordinary locking-bar, and is operated by an electro-magnet, or a second electromotor, &c. 4 claims.

30,917. "Improvements in electrically-operated clocks." R. Burk. Dated December 31st, 1897. Electric clocks with a driving-pendulum, the potential energy of which is restored electro-magnetically. The pendulum carries a pawl which drives a ratchet-wheel tooth by tooth, as determined by masks. When the swing of the pendulum is less than a tooth's thickness, the pawl catches a pendulum lever which makes a lever bridge a gap in the circuit of the electro-magnet for lifting the pendulum. The lower part of the pendulum lever is hinged, and the lever is bevelled to allow the former to resume its position over the latter. The striking-hammer is operated by the pendulum through the medium of a pawl, which is normally held up out of action by means of a retaining hook, but, when the rack hook, having a dependent foot, is lifted from the rack by the pin on the minute wheel, a gravity hook thereon engages the retaining hook, and when the rack hook falls to the rack, the retaining hook is disengaged. When the rackwork drops behind the rack again, as shown, it resets the gravity pawl, the gravity hook having become detached. 3 claims.